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ABSTRACT

This guide contains information to assist education and training facilities in the development and administration of competency-based training that leads to the qualification and certification of trainees in accordance with American Welding Society specifications. The document begins with a description of the scope, objectives, and requirements for certification. The second section defines the occupation of entry-level welder and provides an occupational description, conditions, and task listing. The largest section of the document is made up of the curriculum guidelines, which include general guidelines, a competency-based program outline, and learning modules for six welding courses: occupational orientation, drawing and welding symbol interpretation, arc welding principles and practices, oxyfuel gas cutting principles and practices, arc cutting principles and practices, and welding inspection and testing principles. Each course includes a number of learning objectives and the performance conditions, desired behavior, evaluation criteria, and learning activities needed to meet each objective. Seven appendixes include the following: recommendations for support personnel and systems, the trainee population, facility planning, and personal and shop materials, equipment, and tools; sample training achievement record and certificate of completion, and a list of 35 reference materials. (KC)

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Guide for the Training and Qualification of Welding Personnel

Entry Level Welder

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American Welding Society

AWS EG2.0-95

Guide for the Training and Qualification of Welding Personnel

Entry Level Welders

Funded by
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Prepared by
AWS Education Department

Under the Direction of
AWS Education Grant Committee

Approved by
AWS Board of Directors

Abstract

This guide contains information to assist education and training facilities in the development and administration of competency-based training that leads to the qualification and certification of trainees in accordance with the requirements of AWS QC10, *Specification for the Qualification and Certification for Entry Level Welders*. Included are sections on curriculum and qualification guidelines, as well as recommendations for facility planning, materials, equipment, and tools.

American Welding Society

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A special note of appreciation is extended to each member of the American Welding Society who participated in the industrial survey that helped identify the skill requirements for the Entry Level Welder.

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A special note of appreciation is extended to each member of the AWS General Education Committee who contributed examination questions for the entry level welder test bank.

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Foreword

(This Foreword is not a part of EG2.0-95, *Guide for the Training and Qualification of Entry Level Welders*, but is included for information purposes only.)

The American Welding Society (AWS), recognizing the need for competent entry level welders, through a grant by the U. S. Department of Education (DOEd), formed the Education Grant Committee and assigned them the task of preparing this guide.

Welding has become a very sophisticated and technical science, requiring not only mental application but also hands-on abilities. The future need for competent welders should prompt the establishment of a greater number of educational programs. Thus, it becomes imperative that the training given be of a quality and quantity that adequately prepares trainees for industrial assignments at various levels of skill development well into the next century. To this end, Entry Level Welders come to the workforce as prospective first time practitioners of the craft.

As the name implies, it is the intent of this document to serve as a *Guide* for those wishing to establish, expand, or enhance a private or public training program for Entry Level Welders. The basic requirements contained in this document are established as a result of individuals from a broad range of businesses, job classifications and industrial or educational areas participating in a national survey to identify entry level welder skills. In conjunction with industry's response and the AWS Education Grant Committee's consensus, this document establishes the minimum requirements necessary to standardize the training and qualification of Entry Level Welders throughout the United States of America. Members of the AWS community and the Education Grant Committee have a growing interest in positively promoting welder training and providing minimum standards for it's delivery.

The American Welding Society welcomes comments on this publication, and communications should be addressed to: The American Welding Society, Attention: Director of Education, 550 N. W. LeJeune Road, Miami, Florida, 33126.

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1. General

1.1 Scope. This guide establishes a minimum skill standard defining training and qualification requirements that are necessary for participating organizations to develop and administer an Entry Level Welder Program in accordance with AWS QC10, *Specification for the Qualification and Certification for Entry Level Welders*. This guide is intended to specify a credible path for secondary, post-secondary or employer-based training facilities to build new programs and/or enhance existing programs to administer Entry Level Welder training and qualification. Use of this guide is voluntary. Participating Organizations desiring to certify a trainee as an AWS Certified Entry Level Welder shall consider the training and qualification guidelines within this document as mandatory requirements under the requirements of AWS QC10.

1.2 Objectives

1.2.1 Provide training facilities with an industrial awareness of the occupational description, conditions, task listing, and profile that encompasses the job classification of entry level welder.

1.2.2 Establish a broad competency-based curriculum detailing the minimum acceptable skill requirements for the training and qualification of entry level welders.

1.2.3 Provide training facilities participating in the certification of entry level welders with a list of learning objectives and learning activities necessary to accomplish entry level welder training.

1.2.4 Provide training facilities participating in the certification of entry level welders with the references needed to compare existing or new curriculum with the AWS documents specified in this guide.

1.2.5 Provide training facilities participating in the certification of entry level welders information related to the administration of an entry level welder closed book examination, workmanship qualification, and performance qualification testing.

1.3 Requirements

1.3.1 Unless the secondary, post-secondary or employer-based training facility elects to become a Participating Organization under the requirements of AWS QC10, *Specification for the Qualification and Certification for Entry Level Welders*, use of this document is voluntary.

1.3.2 Participating Organizations shall meet the requirements of AWS QC10, *Specification for the Qualification and Certification for Entry Level Welders*.

1.3.3 Participating Organizations shall ensure that existing or new training materials are in compliance with the AWS documents specified in section *3. Curriculum Guidelines* of this guide.

1.3.4 Participating Organizations shall administer a safety examination prior to trainee performance of tasks in the work area or laboratory, in accordance with the requirements of AWS QC10, *Specification for the Qualification and Certification for Entry Level Welders.*

1.3.5 Participating Organizations shall administer workmanship qualification testing at the end of training for each applicable welding or cutting process in accordance with the requirements of AWS QC10, *Specification for the Qualification and Certification for Entry Level Welders.*

1.3.6 Participating Organizations shall provide a means for trainees to take a closed book written examination based on the applicable subject matter identified in *3. Curriculum Guidelines* of this guide.

1.3.7 Trainees desiring AWS Entry Level Welder Certification shall pass workmanship qualification tests in accordance with the requirements of AWS QC10, *Specification for the Qualification and Certification for Entry Level Welders.*

1.3.8 Trainees desiring AWS Entry Level Welder Certification shall pass a closed book written examination based on the applicable subject matter identified in *3. Curriculum Guidelines* of this guide.

1.3.9 Trainees desiring AWS Entry Level Welder Certification shall pass performance qualification tests in accordance with the requirements of AWS QC10, *Specification for the Qualification and Certification for Entry Level Welders.*

1.3.10 Participating Organizations shall keep training records reflecting the results of entry level welder training, workmanship qualification, closed book examination, and performance qualification.

2. Industrial Awareness

2.1 Scope. Training facilities must understand the needs of industry and provide programs that prepare students to fill these needs. To establish a successful program for welder training, the first step would be to understand the job functions of this person in industry. This is difficult because of the very diverse nature of these functions and the fact that they vary from industry to industry and from company to company. Recognizing this diversity, AWS conducted an industry-wide survey, covering a broad base of businesses, job classifications, and educational institutions, to gather and analyze information, on the skills an entry level welder should have. From a needs assessment and analysis a profile of the entry level welder was developed (refer to figure 1). The profile identifies skill and knowledge areas common to all entry level welders, regardless of their unique situation in industry.

The second step used to understand the function of an entry level welder in industry, was to prepare a task analysis based on the information identified in the entry level welder profile. The results of this analysis included a definition of entry level welder (see 2.2), an occupational description (see 2.3), the occupational conditions (see 2.4) and a task listing sheet (see 2.5). The resulting information is considered common to all entry level welders. Upon completion of the task analysis, technical information topics, materials, equipment, and tools were identified. This information was then converted

from occupational data to programmatic data. The resulting occupational and programmatic data are the heart of this guide. To assist institutions in increasing their awareness of industry's needs, the following sections include portions of the occupational data collected during the needs and task analysis phase of this project.

2.2 Entry Level Welder Definition. An individual employed in this position is considered to possess a prerequisite amount of knowledge, attitude, skills and habits required to perform procedures that involve routine, predictable, repetitive, proceduralized tasks involving motor skills and limited theoretical knowledge while working under close supervision.

2.3 Entry Level Welder Occupational Description. The position is comprised of the following areas:

2.3.1 Common Work Assignments. Follows detailed verbal or written instructions given by an immediate supervisor to set up and carry out specific job assignments. Performs general housekeeping duties to maintain workspace, equipment, and tool cleanliness. Fills out, maintains, and submits a time or work assignment card, record or report as required by the employer's or institution's internal policy. Follows safe practices in the performance of daily duties.

2.3.2 Drawing and Welding Symbol Interpretation. Prepares parts from simple sketches or drawings. Performs welding operations and prepares welded joints from welding symbol information.

2.3.3 Arc Welding. Sets up shielded metal arc welding operations, for all position fillet and groove welding within a limited thickness range of plain carbon steel material. Sets up gas metal arc welding (short circuit transfer) operations, for all position fillet and groove welding within a limited thickness range of plain carbon steel. Sets up gas metal arc welding (spray transfer) operations for limited position and material thickness range on plain carbon steel. Sets up flux cored arc welding operations for all positions, fillet and groove welding within a limited thickness range of plain carbon steel material. Sets up gas tungsten arc welding operations, for all position fillet and groove welding, within a limited thickness range of plain carbon steel material. Performs gas tungsten arc welding operations on aluminum and stainless steel within a limited position, limited material thickness range. Performs minor external repairs to equipment and accessories.

2.3.4 Oxyfuel Gas Cutting. Sets up and performs manual oxyfuel gas cutting operations that include straight and shape cutting, beveling, and weld removal (weld washing). Sets up and operates machine oxyfuel gas cutting equipment (track burner) to perform straight cutting and beveling operations. Performs minor external repairs to equipment and accessories.

2.3.5 Arc Cutting and Gouging. Removes metal using the air carbon arc cutting process. Carries out shape cutting operations using the manual plasma arc cutting process. Performs minor external repairs to equipment and accessories.

2.3.6 Inspection. Visually examines all personal welding and cutting assignments for unfavorable weld and cut edge surface discontinuities before final inspection by a supervisor.

2.4 Entry Level Welder Occupational Conditions

2.4.1 Work Environment. Entry Level Welders are employed in a wide range of industries that use welding and welding-related tasks during the course of daily operations. This range of industries includes small, medium, and large union or non-union facilities.

2.4.2 Occupational Hazards. As is the case in most metalworking industries, the potential for bodily harm and hazardous situations exists. High electrical currents and voltages are used to operate machinery and welding equipment. Machinery for shearing, forming, and punching various thicknesses of materials is used. Flammable and other compressed gases are used during flame cutting and welding operations. The employee may be in direct contact with heavy sections during lifting and positioning operations. Welders may work in enclosed, restricted spaces, and at times at high elevations and in awkward positions. A noise level is sometimes generated during the production process. The welder must take safety precautions, and be safety conscious at all times.

2.4.3 Worker Profile. This position involves concentration, decision making, and physical tasks.

2.4.3.1 Physical Requirements. Entry Level Welders must meet the physical requirements established by the employer.

2.4.3.2 Employability. Entry Level Welders should exhibit good written, oral, and listening skills and be good at problem solving and decision making. These individuals should show good judgement, be dependable and interact well with people.

2.4.3.3 Education. Entry Level Welder training is accomplished through secondary, post-secondary, vocational-technical schools, junior colleges, universities, apprenticeship or employer-based welder training programs. Sufficient workplace skills (i.e. foundation skills such as: reading, writing, math, science, communication skills, and adaptability skills) are required to complete requisite welding-related knowledge and skills training.

2.5 Entry Level Welder Occupational Task Listing (See 3.2 Competency-Based Program Outline)

Note: The task listing from the original occupational analysis is shown in a converted form in 3.2 Competency-Based Program Outline. The occupational task analysis dissects the entry level welder's job functions, provides performance steps and standards of performance for each task, identifies related information topics, basic skills, materials, equipment, and tools, and begins the conversion to a competency based program. Users desiring a thorough analysis of the entry level welder, as seen in the workplace, may do so by ordering the AWS Entry Level Welder, Occupational Task Analysis. This publication is available for sale through the American Welding Society, 550 N. W. LeJeune Road, Miami, FL 33126.

ENTRY LEVEL WELDER PROFILE

[Minimum Training and Qualification Requirements]

BASIC SKILLS AND KNOWLEDGE

READING

- IDENTIFY DETAILS AND SPECIFICATIONS
- FOLLOW DETAILED DIRECTIONS
- USE BOOK MECHANICS (TABLES, INDEX, ETC.)
- LOCATE INFORMATION - PROBLEM SOLVING
  USE FORMS TO LOCATE INFORMATION

→ RECOMMEND ASSESSMENT AND PLACEMENT TESTING PRIOR TO ENTRY INTO THE WELDER TRAINING PROGRAM

WRITING

- WRITE TECHNICAL WORDS ACCURATELY
- SPELL TASK- RELATED WORDS CORRECTLY
- ENTER APPROPRIATE INFORMATION AND ACCURATELY TRANSFER INFORMATION TO FORMS

→ RECOMMEND ASSESSMENT AND PLACEMENT TESTING PRIOR TO ENTRY INTO THE WELDER TRAINING PROGRAM

MATHEMATICS

SYSTEMS
- U. S. CUSTOMARY
- SI METRIC

SKILLS
- ADD, SUBTRACT, MULTIPLY, DIVIDE WHOLE NUMBERS, FRACTIONS, MIXED NUMBERS, AND DECIMALS
- ROUND OFF DECIMALS IN ONE OR MORE PLACES
- USE MEASURING DEVICES TO DETERMINE SIZE, LENGTH, ANGLE, OR DISTANCE
- USE A CALCULATOR TO PERFORM BASIC ARITHMETIC OPERATIONS
- CONVERT MIXED NUMBER FRACTIONS TO DECIMALS AND VICE VERSA
- CONVERT SI (METRIC) TO U.S. (CUSTOMARY) UNITS, AND VICE VERSA
- IDENTIFY GEOMETRIC SHAPES
- UNDERSTAND THE FUNCTIONS OF ANGLES AND PARTS OF A CIRCLE
- PREPARE PARTS USING THE PRINCIPLES OF GEOMETRY
- READ AND USE A U.S. (CUSTOMARY)/SI (METRIC) TAPE, RULE AND SQUARE

→ RECOMMEND ASSESSMENT AND PLACEMENT TESTING PRIOR TO ENTRY INTO THE WELDER TRAINING PROGRAM

COMMUNICATION

LISTENING
- FOLLOW DETAILED VERBAL INSTRUCTIONS

ORAL
- PRONOUNCE KEY TECHNICAL WORDS PRECISELY
- VERBALIZE FACTUAL DETAILS ACCURATELY
- EXPLAIN JOB RELATED MESSAGES AND PROBLEMS CLEARLY

→ RECOMMEND ASSESSMENT AND PLACEMENT TESTING PRIOR TO ENTRY INTO THE WELDER TRAINING PROGRAM

Figure 1— Entry Level Welder Profile. This information was developed as a result of a needs assessment and analysis from a national survey distributed to a mailing from the roles of AWS membership.

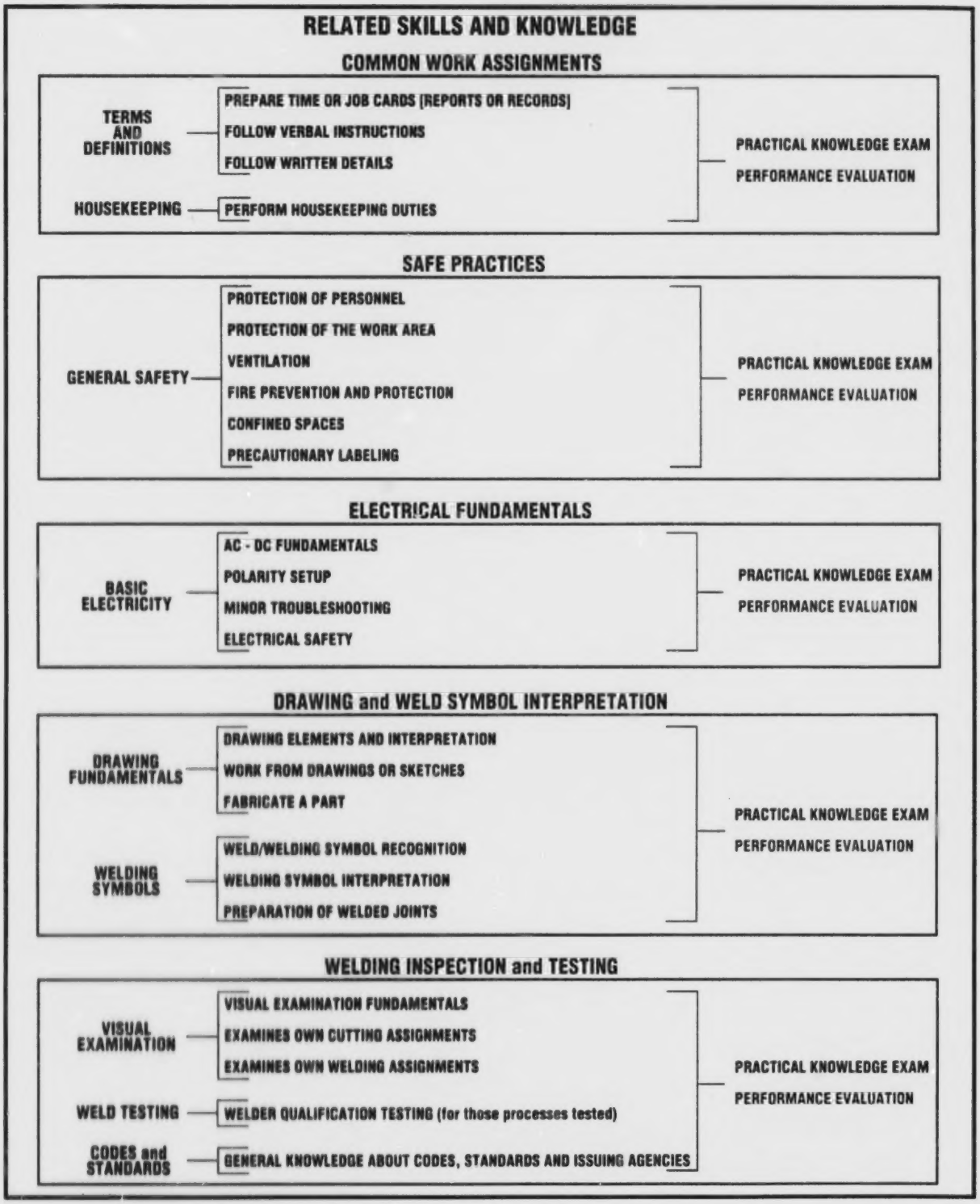

Figure 1 — Entry Level Welder Profile (continued).

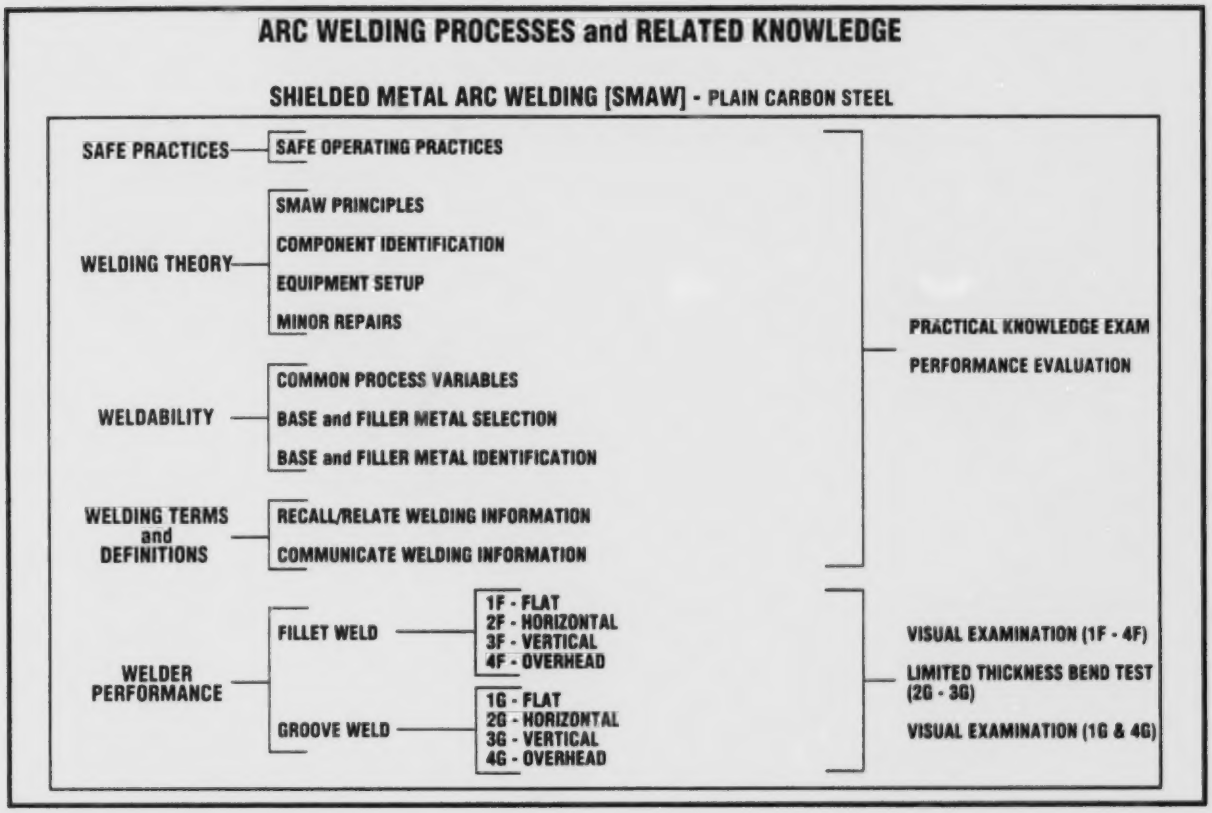

Figure 1 — Entry Level Welder Profile (continued).

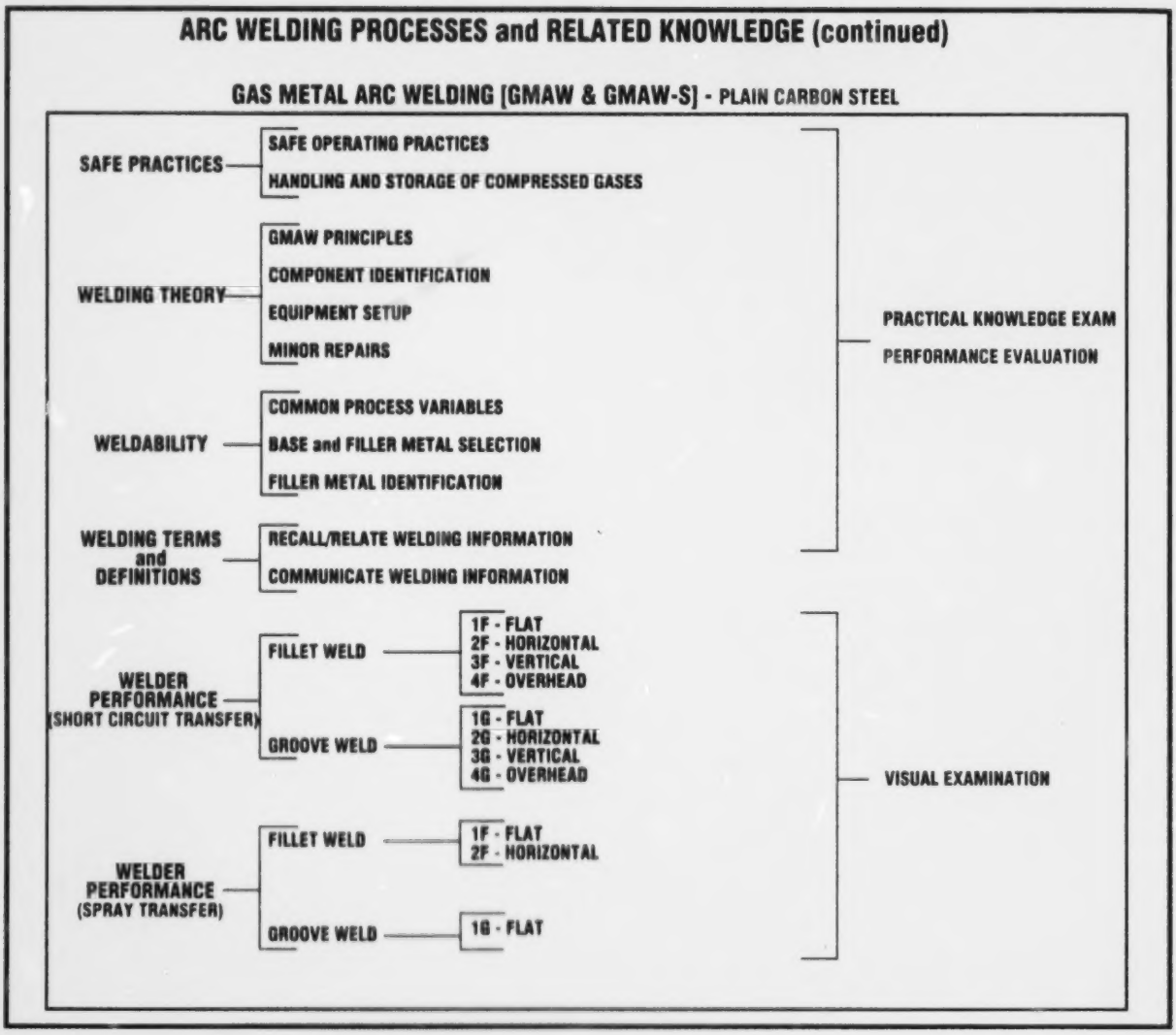

Figure 1 — Entry Level Welder Profile (continued).

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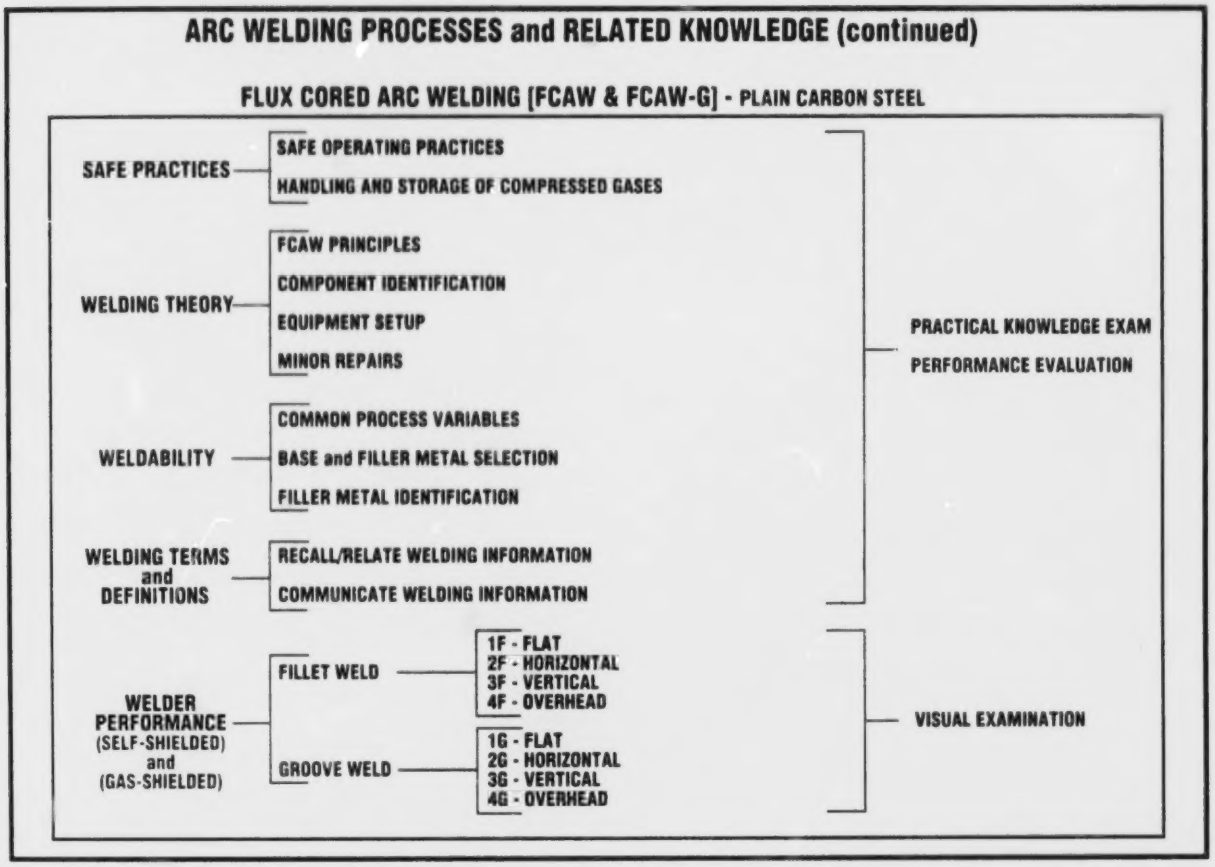

Figure 1 — Entry Level Welder Profile (continued).

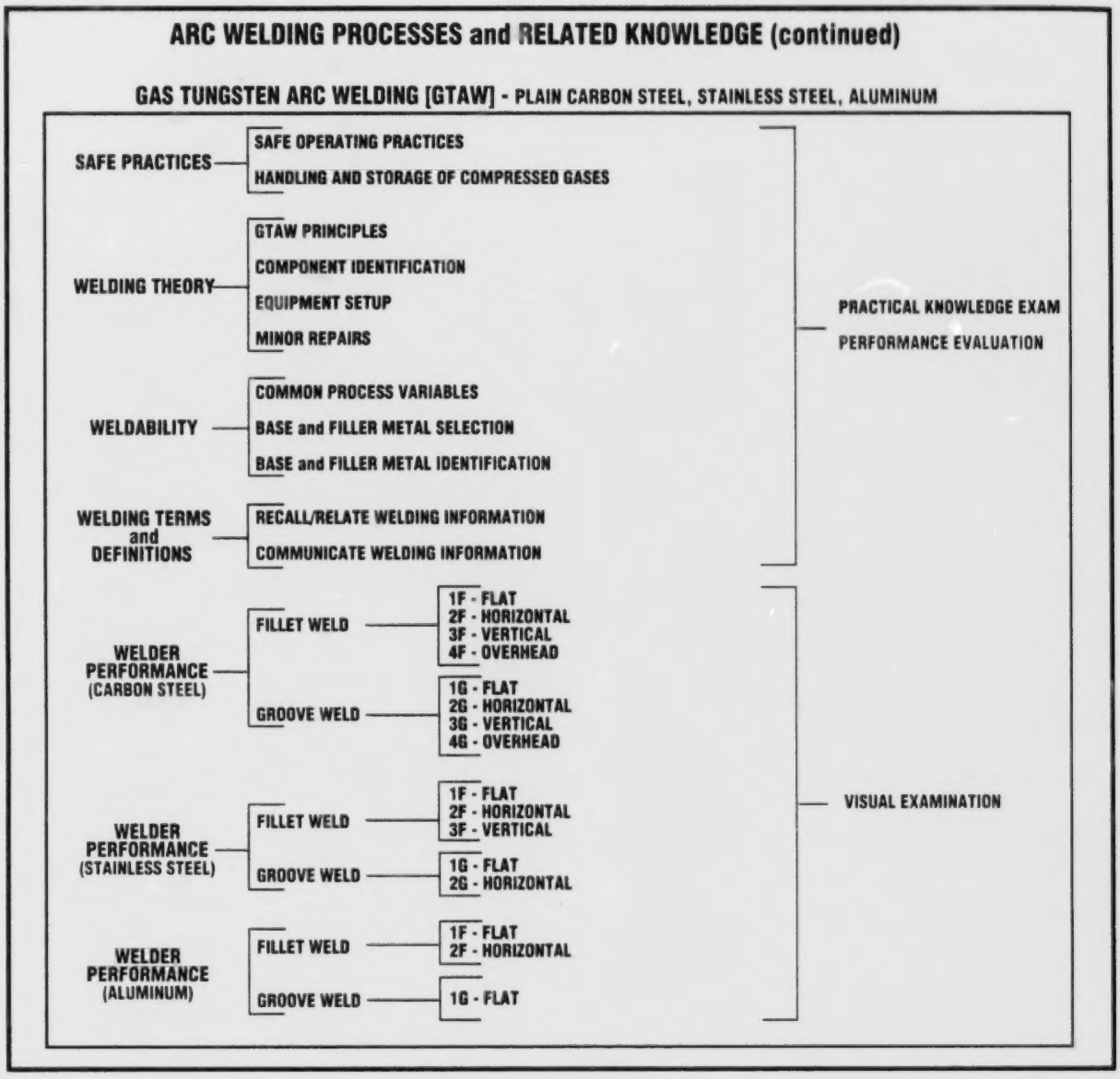

Figure 1 — Entry Level Welder Profile (continued).

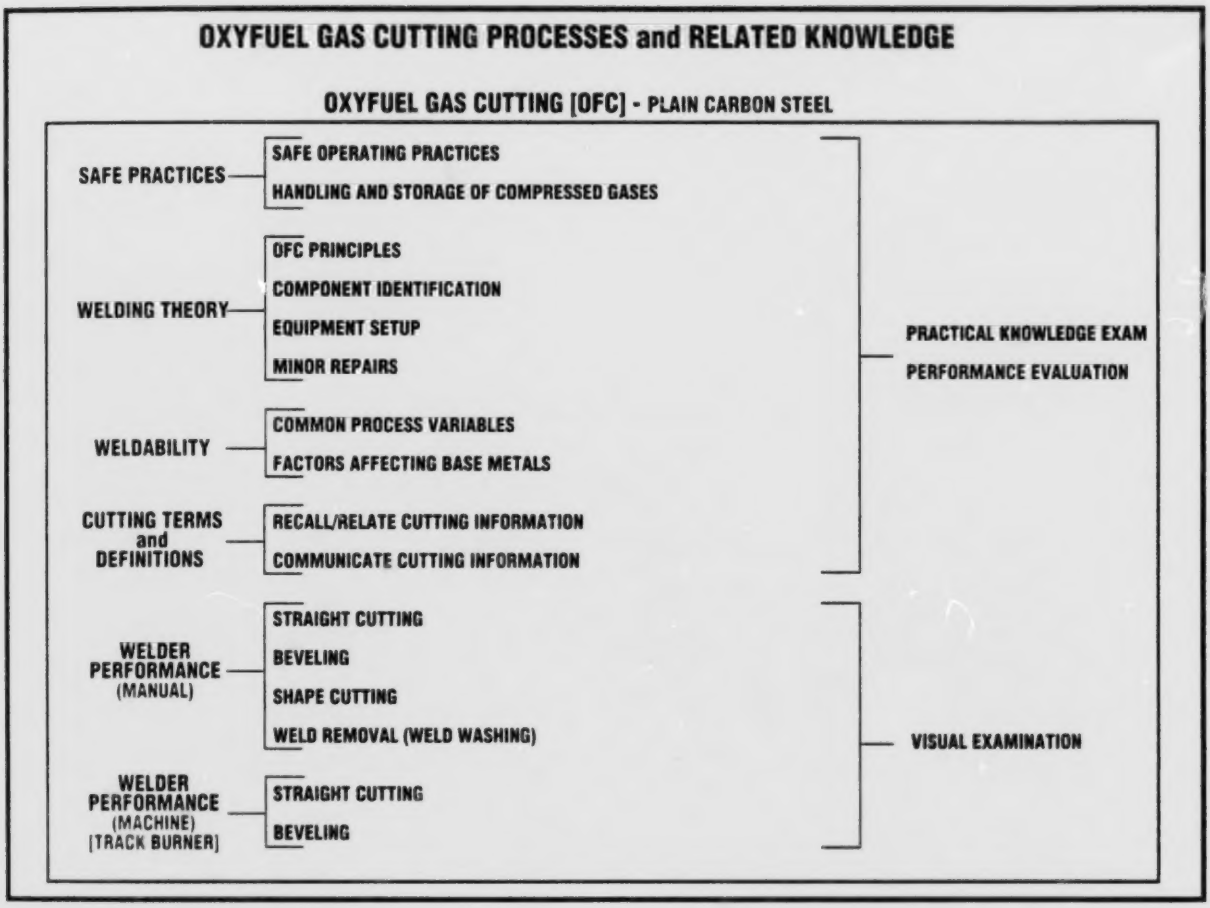

Figure 1 — Entry Level Welder Profile (continued).

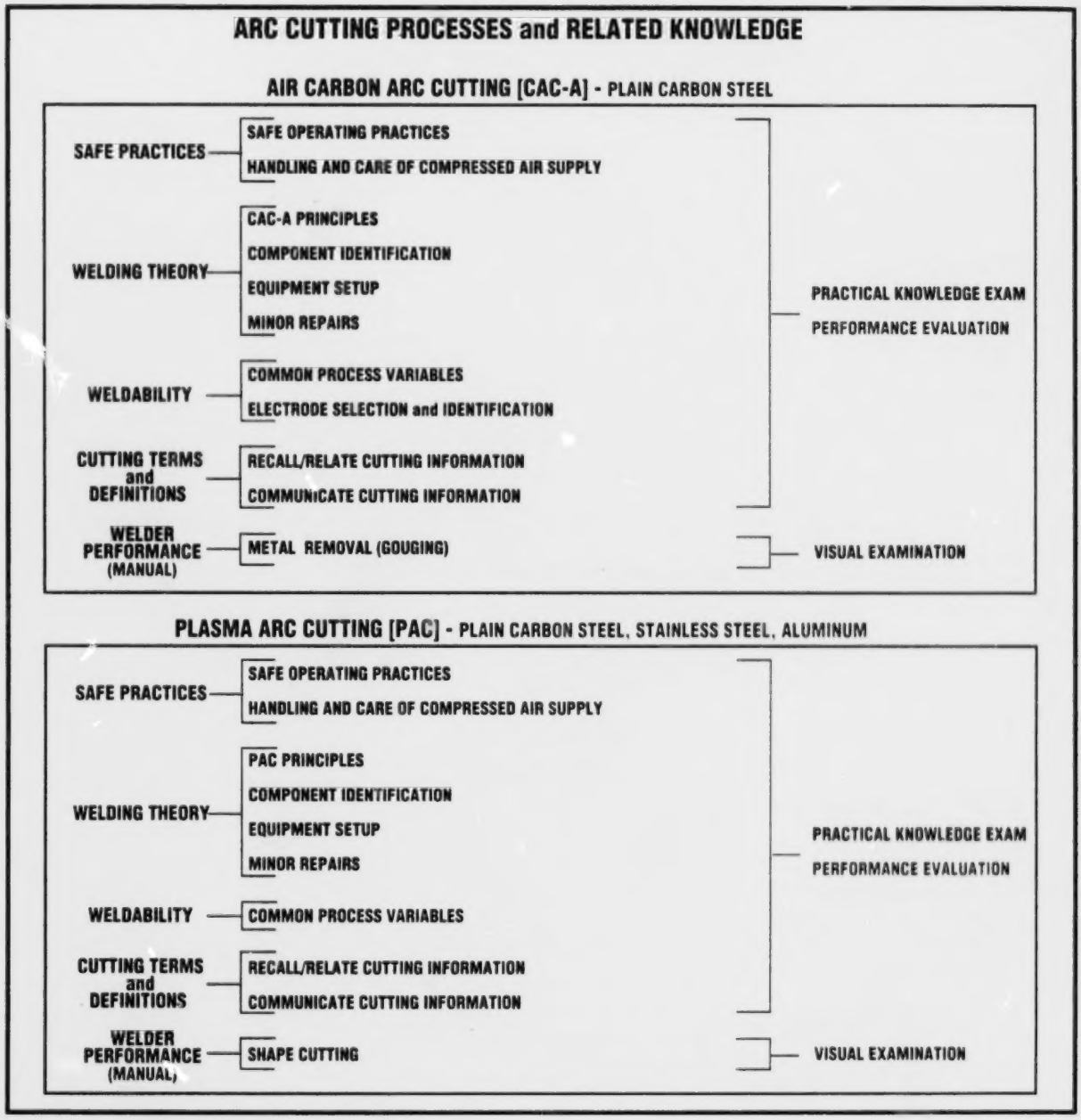

Figure 1 — Entry Level Welder Profile (continued).

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3. Curriculum Guidelines

3.1 General Guidelines. It is the sole intent of this document to define a competency-based welding curriculum. Therefore, it is the responsibility of the secondary, post-secondary or employer-based training program to establish any guidelines for the duration of training and prerequisites related to basic skills (i.e. reading, writing, mathematics and listening/oral communications). Training activities should consistently reinforce the use of basic skills.

3.1.1 Preassessment. The welding industry wants entry level welders with strong reading, writing, mathematics, and listening/oral communication skills that are closely related to job performance. The curriculum in this guide also requires sufficient basic skills to carry out and complete the training. Therefore, it is strongly recommended that prospective trainees undergo a preplacement assessment for basic skill competency prior to entry into the welding program. Further, the competency level for said skills should meet the Grade Level Content or GED Level for the applicable welder level, as defined by the U. S. Department of Labor in the *Dictionary of Occupational Titles*.

3.1.2 Curriculum Conventions. Terminology associated with the curriculum guidelines is defined as follows:

Competency-Based Program Outline: The outline converts the *primary occupation* (i.e. entry level welder), *occupational specialties* (e.g. arc welding), *sub-specialties* (e.g. shielded metal arc welding) and *tasks* (e.g. Perform Safety Inspections of Equipment and Accessories) to a *program title* (i.e. Entry Level Welder Training), *courses* (e.g. Course B: Arc Welding Principles and Practices), units (e.g. Unit #1: Shielded Metal Arc Welding) and *learning objectives* (e.g. Learning Objective #1: Perform safety inspection of equipment and accessories.) The outline assists in modularizing the training program.

Learning Objectives: A written statement cast in the future which defines the *conditions* under which learning will occur and the *criteria* for determining when the objective has been attained. The following elements comprise a learning objective:

Title: A phrase that specifies the activity. The title of a learning objective is the same as the title of the task from which it was derived.

Performance Conditions: A statement which defines the "givens" under which the trainee will perform the objective. In most instances, the conditions define the teaching methods, the equipment, tools materials and supplies given the trainee, and the learning environment where training takes place.

Desired Behavior: A statement, written in the future tense, specifying the activity to be performed.

Evaluation Criteria: A statement which establishes the standard against which the trainee's performance of the objective is measured. The basic elements of evaluation may contain a product statement (when the objective has been performed correctly), and if appropriate, a process statement, inspection, time limitations or repetitions of the objective performed by the trainee over a given period of time.

Learning Modules: A learning module establishes the basis for individualizing the learning objective of the training program. These modules identify and organize learning activities for a learning objective.

Learning Activities: An organizational concept that sequences training events in a systematic approach for guiding trainees to a defined objective. Learning activities consist of *knowledge-related* activities and *performance-related* activities. Knowledge-related learning activities are divided into two types: *knowledge acquisition* - sources of information which provide the knowledge needed to perform the learning activity; and i*nformation review* and *testing* (formative testing) activities which guide the instructor in reviewing and assessing the trainee's performance of the learning objective. Knowledge-related learning activities are brought to a close with the trainee's successful completion of a related information test (formative testing). Performance-related learning activities provide the instructor with a means by which to guide the trainee in attaining the objective. Utilizing the now-acquired technical information to guide his or her actions, the trainee receives a *demonstration* of the objective, *practices* performing it until an acceptable level of skill and confidence is gained, and takes a *performance test* (i.e. workmanship qualifications) of the same to confirm mastery of the objective. Other performance-related activities may be included in the basic sequence, but the demonstration-practice-performance trilogy is fundamental to ordering performance-related activities.

Workmanship Qualification: A practical application test with elements that include drawing interpretation, fabrication, and welding symbol interpretation. The test is evaluated in three stages and each stage must be completed correctly before moving to the next. The first stage is the preparation of a bill of materials in U. S. customary units of measure, then conversion of those units of measure to SI metric units. The first stage measures drawing interpretation and basic math skills. Upon successful completion of stage one, the trainee fabricates and assembles the weldment. The second stage measures fabrication skills. Upon successful completion of the second stage, the trainee, welds the assembly according to welding symbol information. The final stage measures a trainee's ability to interpret welding symbol information and use of manipulative skills. All stages of testing are evaluated using, visual examination criteria. Workmanship qualifications are *summative tests* and may be conducted at any time during training, once the trainee has completed skills training for the welding and cutting processes specified. (Refer to Figures 2 through 6.)

Closed Book Examination: A practical knowledge test for welding related knowledge. This examination will measure the trainee's knowledge, comprehension and application of major subject matter concepts from classroom instruction. This summative test is administered at the end of the training cycle, before standard performance qualification.

Standard Performance Qualification: A practical application test of manipulative skills using the SMAW process. The test for an entry level welder requires groove welding in the 2G (horizontal) and 3G (vertical up) positions. Performance is measured using visual examination and bend test criteria. This *summative test* is conducted at the end of the training cycle. The trainee shall pass the closed book examination before taking this set of tests. (Refer to Figure 7.)

3.1.3 Curriculum Implementation.

3.1.3.1 Review. Participating Organizations shall review part **3.2 Competency-Based Program Outline** (all inclusive) and **3.3 Learning Modules** (all inclusive), prior to the introduction of the curriculum into the training cycle.

Note: The Competency-Based Program Outline should not be construed as the steps necessary to administer the curriculum. It, as the title implies, is an outline that may be used to quickly identify a point in training. The Learning Modules are the heart of the curriculum and contain sufficient information for instructors to deliver the training and evaluate a trainee's performance. Learning Modules include course title, learning objectives, performance conditions, desired behavior, evaluation criteria and learning activities.

3.1.3.2 Verification. Participating Organizations shall ensure that their existing or newly developed curriculum is in compliance with all AWS documents specified in part **3.3 Learning Modules**. Verification shall be made in writing in accordance with AWS QC10, *Specification for the Qualification and Certification for Entry Level Welders.*

3.1.3.3 Lesson Plan Development. Participating Organizations shall develop appropriate lesson plans that include each learning objective and the learning activities specified for each course or unit within a course. (Refer to 3.3 Learning Modules.)

Note: Not all learning objectives are stand alone in terms of instruction. Some are delivered through a minimum period of instruction and reinforced throughout the training cycle. Determination of stand alone or continuous reinforcement is identified in the evaluation criteria for each learning objective.

3.1.3.4 Delivery. Participating Organizations shall deliver training in accordance with the learning objectives and learning activities detailed in **3.3 Learning Modules.**

3.1.3.5 Testing. Participating Organizations shall develop and administer appropriate formative tests during and after the completion of classroom instruction. Summative testing for workmanship qualification, figures 2 through 6, should be administered at the end of training in each applicable welding or cutting process. Workmanship qualifications must be administered prior to summative testing for practical knowledge and performance qualification. Summative testing for practical knowledge, and performance qualification (figure 7), shall be administered at the end of the training cycle in accordance with the requirements of AWS QC10, *Specification for the Qualification and Certification for Entry Level Welders.*

3.1.3.6 Record Keeping. Participating Organizations shall develop appropriate records that track each trainee's achievements. In addition, appropriate records shall be developed so that trainees may keep a self-record of achievement. See Annex E.

3.2 Competency Based Program Outline

3.2.1 Program: ENTRY LEVEL WELDER TRAINING

3.2.1.1 COURSE A: OCCUPATIONAL ORIENTATION

Unit : (no units this course)
Learning Objectives
(1) Follow safe practices.
(2) Prepare time or job cards, reports or records.
(3) Perform housekeeping duties.
(4) Follow verbal instructions to complete work assignments.
(5) Follow written details to complete work assignments.

3.2.1.2 COURSE B: DRAWING AND WELDING SYMBOL INTERPRETATION

Unit : (no units this course)
Learning Objectives
(1) Interpret basic elements of a drawing or sketch.
(2) Interpret welding symbol information.
(3) Fabricate parts from a drawing or sketch.

3.2.1.3 COURSE C: ARC WELDING PRINCIPLES and PRACTICES

Unit 1: Shielded Metal Arc Welding (SMAW)
Learning Objectives
(1) Perform safety inspections of equipment and accessories.
(2) Make minor external repairs to equipment and accessories.
(3) Set up for shielded metal arc welding operations on plain carbon steel.
(4) Operate shielded metal arc welding equipment.
(5) Make fillet welds, all positions, on plain carbon steel.
(6) Make groove welds, all positions, on plain carbon steel.
(7) Perform 2G - 3G limited thickness qualification tests on plain carbon steel plate.

Unit 2: GAS METAL ARC WELDING (GMAW, GMAW-S)
Learning Objectives
(1) Perform safety inspections of equipment and accessories.
(2) Make minor external repairs to equipment and accessories.
(3) Set up for gas metal arc welding operations on plain carbon steel.
(4) Operate gas metal arc welding equipment.
Short circuit transfer
(5) Make fillet welds, all positions, on plain carbon steel.
(6) Make groove welds, all positions, on plain carbon steel.
Spray transfer
(7) Make 1F - 2F welds on plain carbon steel.
(8) Make 1G welds on plain carbon steel.

Unit 3: FLUX CORED ARC WELDING (FCAW, FCAW-G)

Learning Objectives

(1) Perform safety inspections of equipment and accessories.
(2) Make minor external repairs to equipment and accessories.
(3) Set up for flux cored arc welding operations on plain carbon steel.
(4) Operate flux cored arc welding equipment.
(5) Make fillet welds, all positions, on plain carbon steel.
(6) Make groove welds, all positions, on plain carbon steel.

Unit 4: GAS TUNGSTEN ARC WELDING (GTAW)

Learning Objectives

(1) Perform safety inspections of equipment and accessories.
(2) Make minor external repairs to equipment and accessories.
(3) Set up for gas tungsten arc welding operations on plain carbon steel, aluminum, and stainless steel.
(4) Operate gas tungsten arc welding equipment.
(5) Make fillet welds, all positions, on plain carbon steel.
(6) Make groove welds, all positions, on plain carbon steel.
(7) Make 1F - 2F welds on aluminum.
(8) Make 1G welds on aluminum.
(9) Make 1F - 3F welds on stainless steel.
(10)Make 1G - 2G welds on stainless steel.

3.2.1.4 COURSE D: OXYFUEL GAS CUTTING PRINCIPLES and PRACTICES

Unit 1: MANUAL OXYFUEL GAS CUTTING (OFC)

Learning Objectives

(1) Perform safety inspections of equipment and accessories.
(2) Make minor external repairs to equipment and accessories.
(3) Set up for manual oxyfuel gas cutting operations on plain carbon steel.
(4) Operate manual oxyfuel cutting equipment.
(5) Perform straight cutting operations on plain carbon steel.
(6) Perform shape cutting operations on plain carbon steel.
(7) Perform bevel cutting operations on plain carbon steel.
(8) Remove weld metal from plain carbon steel using weld washing techniques.

Unit 2: MACHINE OXYFUEL GAS CUTTING (OFC)-[TRACK BURNER]

Learning Objectives

(1) Perform safety inspections of equipment and accessories.
(2) Make minor external repairs to equipment and accessories.
(3) Set up for machine oxyfuel gas cutting (track burner) operations on plain carbon steel.
(4) Operate machine oxyfuel gas cutting (track burner) equipment.
(5) Perform straight cutting operations on plain carbon steel.
(6) Perform bevel cutting operations on plain carbon steel.

3.2.1.5 **COURSE E:** ARC CUTTING PRINCIPLES and PRACTICES

Unit1: AIR CARBON ARC CUTTING (CAC-A)

Learning Objectives

(1) Perform safety inspections of equipment and accessories.
(2) Make minor external repairs to equipment and accessories.
(3) Set up for manual air carbon arc gouging and cutting operations on plain carbon steel.
(4) Operate manual air carbon arc cutting equipment.
(5) Perform metal removal operations on plain carbon steel.

Unit 2: PLASMA ARC CUTTING (PAC)

Learning Objectives

(1) Perform safety inspections of equipment and accessories.
(2) Make minor external repairs to equipment and accessories.
(3) Set up for manual plasma arc cutting operations on plain carbon steel, aluminum, and stainless steel.
(4) Operate manual plasma arc cutting equipment.
(5) Perform shape cutting operations on plain carbon steel, aluminum, and stainless steel.

3.2.1.6 **COURSE F:** WELDING INSPECTION and TESTING PRINCIPLES

Unit 1: VISUAL EXAMINATION PRINCIPLES AND PRACTICES

Learning Objectives

(1) Examine cut surfaces and edges of prepared base metal parts.
(2) Examine tack, intermediate layers, and completed welds.

3.3 LEARNING MODULES

3.3.1 COURSE A: OCCUPATIONAL ORIENTATION

LEARNING OBJECTIVE #1: Follow Safe Practices.

PERFORMANCE CONDITIONS: Provided with a period of instruction, orientation and demonstration about general welding safety, and given the necessary personal protective clothing and equipment, in the work area.

DESIRED BEHAVIOR: the trainee demonstrates safe practices.

EVALUATION CRITERIA: With regard to the trainee, proper protective clothing and equipment are worn, a safe work area is maintained and hazard warnings are communicated to other personnel in the immediate vicinity. The trainee performs the task on a continuous basis over the length of the program, in accordance with the institution's safety policy. Prior to any performance related activity in the institution's work area, the trainee shall pass with 100% accuracy, a written safety examination related to applicable sections of ANSI Z49.1 *Safety in Welding, Cutting and Allied Processes*, and the participating organization's internal safety policy. The trainee may retest until 100% accuracy is achieved.

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide safety tour and orientation in the institution's welding work area.
3. Provide demonstrations related to ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes*, 4. Protection of Personnel and the General Area.
4. Provide demonstrations related to ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes*, 5. Ventilation.
5. Provide demonstrations related to ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes*, 6. Fire Prevention and Protection.
6. Provide demonstrations related to ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes*, 9. Precautionary Information.
7. Provide instruction related to ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes*, Part 1 - General Aspects.
8. Administer safety examination prior to trainee performance in the institution's work area.
9. Administer safety examination retests as applicable.
10. Keep records reflecting successful completion of safe practice training.

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LEARNING OBJECTIVE #2 Prepare time or job cards, reports or records.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, a time record, and job or work assignment number.

DESIRED BEHAVIOR: the trainee records personal training and job assignment information.

EVALUATION CRITERIA: The trainee's, time records are completed in accordance with the institution's standard operating procedures. The record is returned or entered into the proper filing area or storage media. The trainee performs the task on a continuous basis over the length of the program. The trainee's completed record is compared against the instructor's master record for accuracy.

LEARNING ACTIVITIES:

The instructor shall:

1. Develop a trainee achievement record.
2. Develop a trainee time record.
3. Demonstrate procedures for completion of training achievement records and time cards.
4. Provide instruction related to time and job recording methods related to the welding industry.
5. Provide training exercises related to trainee maintenance of a training achievement record.
6. Provide training exercises related to trainee maintenance of a time card.
7. Monitor individual training achievement records and time cards.
8. Keep training records reflecting trainee achievement and attendance.

LEARNING OBJECTIVE #3: Perform housekeeping activities.

PERFORMANCE CONDITIONS: Provided with a period of orientation, housekeeping equipment or tools, and given a housekeeping assignment, in the work area.

DESIRED BEHAVIOR: the trainee will carry out housekeeping activities.

EVALUATION CRITERIA: The trainee's completed assignments show evidence of good housekeeping and safety practices. The assignment is completed in accordance with the institution's standard operating procedure. The task is completed in a timely manner. The trainee's workmanship is observed by the instructor on a routine basis over the length of the program.

LEARNING ACTIVITIES:

The instructor shall:

1. Outline common housekeeping activities shared by all trainees.
2. Outline individual housekeeping responsibilities.
3. Provide housekeeping activities for all trainees.
4. Monitor and inspect completed individual and shared housekeeping assignments.
5. Keep training records reflecting trainee housekeeping habits.

LEARNING OBJECTIVE #4: Follow verbal instructions to complete work assignments.

PERFORMANCE CONDITIONS: Given verbal work assignment instructions and the required materials, equipment or tools, in the work area,

DESIRED BEHAVIOR: the trainee will carry out a job assignment.

EVALUATION CRITERIA: The trainee's work assignment is completed according to verbal instructions. The instructor observes the trainee selecting the necessary materials, equipment, or tools to meet service conditions for the job requirements. The trainee sets up and completes assignments in a timely manner. Verbal instructions are carried out on a routine basis over the length of the program. In accordance with the requirements of AWS QC10, the trainee shall pass the welding terms and definitions element of a summative closed book examination from the related sections of ANSI/AWS A3.0, *Standard Welding Terms and Definitions*.

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Develop training exercises that require a trainee to follow verbal instructions and use proper terms and definitions during the course of communication.
3. Observe each trainee selecting the required materials, equipment and tools for each exercise.
4. Observe each trainee's ability to carry out training exercises.
5. Develop and administer formative or diagnostic tests relevant to welding terms and definitions.
6. Prepare trainee for the welding terms and definitions element of a summative closed book examination [summative testing].
7. Keep training records reflecting each trainee's listening and oral communication skills.

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LEARNING OBJECTIVE #5: Follow written instructions to complete work assignments.

PERFORMANCE CONDITIONS: Given written work assignment instructions and the required materials, equipment or tools, in the work area,

DESIRED BEHAVIOR: the trainee will carry out a job assignment.

EVALUATION CRITERIA: The trainee's work assignment is completed according to written instructions. The trainee is observed by the instructor selecting the necessary materials, equipment or tools to meet service conditions for the job requirements. The trainee sets up and completes the assignment in a timely manner. Written instructions are carried out on a routine basis over the length of the program. In accordance with the requirements of AWS QC10, the trainee shall pass the welding terms and definitions element of a summative closed book examination from the related sections of ANSI/AWS A3.0, *Standard Welding Terms and Definitions*.

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide instruction in welding terms and definitions.
3. Develop training exercises that require a trainee to follow written instructions.
4. Observe each trainee selecting the required materials, equipment and tools for each exercise.
5. Observe each trainee's ability to carry out training exercises.
6. Develop and administer formative or diagnostic tests relevant to welding terms and definitions.
7. Prepare trainee for the welding terms and definitions element of a summative closed book examination [summative testing].
8. Keep training records reflecting each trainee's written communication skills.

3.3.2 COURSE B: DRAWING and WELD SYMBOL INTERPRETATION

LEARNING OBJECTIVE #1: Interpret basic elements of a drawing or sketch.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, and practice, a drawing or sketch, pen or pencil, notepad, hand held calculator, at a work area table,

DESIRED BEHAVIOR: the trainee will prepare to layout the individual parts of a welded assembly.

EVALUATION CRITERIA: Fabrication requirements are identified according to drawing or sketch specifications by the trainee. The objective is practiced on a routine basis over the length of the program. The instructor observes the trainee preparing to layout according to fabrication requirements. Workmanship sample information is correctly interpreted during workmanship and performance qualification testing and verified by the test supervisor. In accordance with the requirements of AWS QC10, the trainee shall pass the drawing fundamentals element of a summative closed book examination [summative testing].

LEARNING ACTIVITIES:

The instructor shall:

1. Provide an introduction to drawing or sketch reading.
2. Provide instruction in drawing view interpretation.
3. Provide instruction in title block interpretation.
4. Provide instruction in drawing notes interpretation.
5. Provide instruction in drawing change system interpretation.
6. Provide instruction in drawing list of materials and parts list interpretation.
7. Provide instruction in drawing dimensions and tolerances for both U.S. (customary) and SI (metric) units.
8. Demonstrate drawing element interpretation.
9. Introduce related terms and definitions.
10. Provide training exercises related to drawing and sketch interpretation.
11. Develop and administer formative or diagnostic tests relevant to drawing fundamentals.
12. Prepare trainee for the drawing fundamentals element of a summative closed book examination [summative testing].
13. Keep training records reflecting results of drawing element interpretation requirements.

LEARNING OBJECTIVE #2 Interpret welding symbol information.

PERFORMANCE CONDITIONS: Provided with instruction and demonstration, drawings or sketches with welding symbols and supplementary data.

DESIRED BEHAVIOR: the trainee will locate, review and determine welding requirements.

EVALUATION CRITERIA: The trainee identifies welding requirements according to welding symbol information. The objective is practiced on a routine basis over the length of the program. In accordance with the requirements of AWS QC10, the trainee shall pass the welding symbol element of a summative closed book examination from the related sections of ANSI/AWS A2.4, *Standard Symbols for Welding, Brazing and Nondestructive Examination.*

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide instruction in welding symbol interpretation.
3. Demonstrate welding symbol interpretation.
4. Provide training exercises related to welding symbol interpretation.
5. Introduce related terms and definitions.
6. Observe trainee carrying out welding requirements from welding symbol information.
7. Develop and administer formative or diagnostic tests relevant to welding symbol information.
8. Prepare trainee for the welding symbol element of a summative closed book examination from the related sections of ANSI/AWS A2.4, *Standard Symbols for Welding, Brazing and Nondestructive Examination.*
9. Keep training records reflecting results of welding symbol interpretation requirements.

LEARNING OBJECTIVE #3 Fabricate parts from a drawing or sketch.

PERFORMANCE CONDITIONS: Provided with a drawing or sketch, layout tools, measuring devices, a handheld calculator, fabrication and welding equipment, base metals, at a work area table.

DESIRED BEHAVIOR: the trainee fabricates parts.

EVALUATION CRITERIA: The trainee prepares, assembles, and tack welds parts according to drawing or sketch specifications. The objective is practiced on a routine basis over the length of the program. In accordance with the requirements of AWS QC10, the trainee shall pass the fabrication and weld symbol interpretation elements of workmanship qualification.

LEARNING ACTIVITIES:

The instructor shall:

1. Provide safety tour and orientation to fabrication tools and equipment.
2. Provide instruction in fabrication tools and equipment safe practices.
3. Provide instruction in the care and use of fabrication tools and equipment.
4. Provide instruction in base metal identification and shapes.
5. Provide instruction in welded joint geometry.
6. Demonstrate the selection and use of fabrication tools and equipment.
7. Demonstrate fabrication techniques.
8. Demonstrate the preparation of welded joints.
9. Provide written fabrication exercises with U.S. (customary) elements for welding practices.
10. Provide written fabrication exercises with SI (metric) elements for welding practices.
11. Observe trainee selecting fabrication tools and equipment.
12. Observe trainee selecting base metals.
13. Observe trainee performance during various stages of fabrication.
14. Observe trainee following safe practices.
15. Develop and administer formative or diagnostic tests relevant to fabrication and weld symbol interpretation.
16. Prepare trainee for the fabrication and weld symbol interpretation elements of workmanship qualifications.
17. Keep training records reflecting results of fabrication from drawing or sketches requirements.

3.3.3 COURSE C: ARC WELDING PRINCIPLES & PRACTICES

3.3.3.1 UNIT #1: SHIELDED METAL ARC WELDING (SMAW)

LEARNING OBJECTIVE #1: Perform safety inspections of equipment and accessories.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration and safety inspection guidelines, protective clothing and equipment, shielded arc welding equipment, accessories and hand tools, in the work area.

DESIRED BEHAVIOR: the trainee performs safety inspections of protective equipment and clothing, shielded metal arc welding equipment and accessories, required tools and the work area.

EVALUATION CRITERIA: The trainee's protective equipment and clothing, work area, welding equipment, accessories, and hand tools meet safety requirements. Hazard warnings are communicated to others in the immediate area prior to the start of shielded metal arc welding operations. In the course of daily operations, the trainee is observed following safe practices. The objective is performed as required during the shielded metal arc welding portion of the program. In accordance with the requirements of AWS QC10, the trainee shall pass the arc welding safety portion of a summative closed book examination from the related sections of ANSI Z49.1 *Safety in Welding, Cutting and Allied Processes*.

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide safety tour and orientation to shielded metal arc welding equipment and accessories.
3. Provide demonstrations related to ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes*, Part II- Specific Processes, 11. Arc Welding and Cutting Equipment Safety.
4. Provide demonstrations related to routine safety inspections of protective equipment and clothing, shielded metal arc welding equipment and accessories, required tools and the work area.
5. Provide instruction related to ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes*, Part II - Specific Processes, 11. Arc Welding and Cutting Equipment Safety.
6. Reinforce previous instruction from ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes*, Part I - General Aspects.
7. Introduce related terms and definitions.
8. Observe trainee conducting safety inspections.
9. Observe trainee following safe practices.
10. Observe trainee using proper terms and definitions.
11. Develop and administer formative or diagnostic tests relevant to safe arc welding practices.
12. Prepare trainee for the arc welding safety portion of a summative closed book examination from the related sections of ANSI Z49.1 *Safety in Welding, Cutting and Allied Processes*.
13. Keep records reflecting successful completion of SMAW safe practices training.

LEARNING OBJECTIVE #2 Make minor external repairs to equipment and accessories.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, and repair materials, equipment or tools, in the work area,

DESIRED BEHAVIOR: the trainee will make minor external repairs to shielded metal arc welding equipment and accessories.

EVALUATION CRITERIA: The trainee's repairs on arc welding equipment and accessories are made in accordance with the manufacturer's recommendations and the institution's repair policy. The correct repair materials, equipment, or tools are selected. The assignment is completed in a timely manner. The objective is performed as required during the shielded metal arc welding portion of the program. In accordance with the requirements of AWS QC10, the trainee shall pass the shielded metal arc welding component identification portion of a summative closed book examination from the related sections of AWS Welding Handbook, Volume 2, Eighth Ed., *Welding Processes.*

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide demonstrations related to shielded metal arc welding equipment and accessory component identification.
3. Provide instruction related to shielded metal arc welding equipment and accessory component identification.
4. Provide demonstrations related to minor external repairs on shielded metal arc welding equipment and accessories.
5. Provide instruction related to minor external repairs to shielded metal arc welding equipment and accessories.
6. Introduce related terms and definitions.
7. Provide trainee with repair assignments when required.
8. Observe trainee following safe repair practices.
9. Observe trainee using proper terms and definitions.
10. Develop and administer formative or diagnostic tests relevant to shielded metal arc welding component identification.
11. Prepare trainee for the shielded metal arc welding component identification portion of a summative closed book examination from the related sections of AWS Welding Handbook. Volume 2, Eighth Ed., *Welding Processes.*
12. Keep training records reflecting results of shielded metal arc welding component identification.

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LEARNING OBJECTIVE #3 Set up for shielded metal arc welding operations on plain carbon steel.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, verbal or written instructions, protective clothing and equipment, shielded metal arc welding equipment, accessories, hand tools, base metal and E6010 or E6011, and E7018 electrodes, in the work area.

DESIRED BEHAVIOR: the trainee will set up and prepare to perform shielded metal arc welding operations on plain carbon steel.

EVALUATION CRITERIA: The trainee is prepared to weld. Verbal or written instructions are understood. Protective clothing and equipment are suitable for job requirements. The proper hand tools, equipment, base metal, and electrodes are selected. Shielded metal arc welding equipment is set up and adjusted for the proper current and polarity. Parts are assembled and preheated according to job requirements. The objective is performed on a routine basis during the shielded metal arc welding portion of the program. In accordance with the requirements of AWS QC10, the trainee shall pass the shielded metal arc welding principles of operation, base/filler metal selection and identification portion of a summative closed book examination from the related sections of AWS Welding Handbook, Volume 1, Eighth Ed., *Welding Technology*, Volume 2, Eighth Ed., *Welding Processes and* ANSI/AWS A5.1, *Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding.*

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide instruction in AC/DC principles.
3. Provide demonstrations related to shielded metal arc welding equipment and accessory set up.
4. Provide instruction in shielded metal arc welding principles of operation.
5. Provide instruction in plain carbon steel shapes, identification and selection.
6. Provide instruction in the shielded metal arc welding filler metal identification and selection.
7. Introduce related terms and definitions.
8. Provide trainee with practice setting up shielded metal arc welding equipment and accessories.
9. Observe trainee following safe practices.
10. Observe trainee using proper terms and definitions.
11. Observe trainee setting up shielded metal arc welding equipment and accessories.
12. Develop and administer formative or diagnostic tests relevant to AC/DC principles, shielded metal arc welding principles of operation, and base/filler metal identification and selection.
13. Prepare trainees for the shielded metal arc welding principles of operation, plain carbon steel base/filler metal selection and identification portion of a summative closed book examination from the related sections of AWS Welding Handbook, Volume 1, Eighth Ed., *Welding Technology*, Volume 2, Eighth Ed., *Welding Processes and* ANSI/AWS A5.1, *Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding.*
14. Keep training records reflecting results of shielded metal arc welding equipment set up, principles of operation and base/filler metal identification and selection.

LEARNING OBJECTIVE #4 Operate shielded metal arc welding equipment.

PERFORMANCE CONDITIONS: Provided with a period of instruction, and demonstration, protective clothing and equipment, shielded metal arc welding equipment, accessories, E6010 or E6011, and E7018 electrodes, hand tools, base metal or an assembly and a welding assignment, in the work area,

DESIRED BEHAVIOR: the trainee will perform shielded metal arc welding operations.

EVALUATION CRITERIA: The trainee's welding was completed as required by the welding assignment. During and after the operation, welds were visually examined by the trainee and accepted by the instructor. The objective is performed on a routine basis during the shielded metal arc welding portion of the program. In accordance with the requirements of AWS QC10, the trainee shall pass the shielded metal arc welding principles of operation and common process variables portion of a summative closed book examination from the related section of AWS Welding Handbook, Volume 2, Eighth Ed., *Welding Processes.*

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide demonstrations related to shielded metal arc welding equipment operations.
3. Provide instruction related to shielded metal arc welding principles of operation.
4. Provide instruction related to common process variables for shielded metal arc welding.
5. Provide training exercises related to shielded metal arc welding equipment operation.
6. Provide training exercises related to starting and maintaining an arc on plain carbon steel, using E6010 or E6011, and E7018 electrodes.
7. Provide training exercises related to flat single pass surfacing welds on plain carbon steel, using E6010 or E6011, and E7018 electrodes.
8. Provide training exercises related to flat multiple pass, multi-directional, surfacing welds on plain carbon steel, using E6010 or E6011, and E7018 electrodes.
9. Observe trainee's following safe arc welding practices.
10. Observe trainee's operating shielded metal arc welding equipment.
11. Visually inspect trainee's workmanship samples.
12. Develop and administer formative or diagnostic tests relevant to shielded metal arc welding principles of operation and common process variables.
13. Prepare trainee for the shielded metal arc welding principles of operation and common process variables portion of a summative closed book examination from the related sections of AWS Welding Handbook, Volume 2, Eighth Ed., *Welding Processes.*
14. Keep training records reflecting results of shielded metal arc welding equipment principles of operation, common process variables and performance exercises.

LEARNING OBJECTIVE #5 Make fillet welds, all positions, on plain carbon steel, using the shielded metal arc welding process.

PERFORMANCE CONDITIONS: Provided with a period of demonstration, protective clothing and equipment, shielded metal arc welding equipment, accessories, E6010 or E6011, and E7018 electrodes, base metal or an assembly, hand tools, and a welding assignment, in the work area.

DESIRED BEHAVIOR: the trainee will make fillet welds on plain carbon steel in all positions.

EVALUATION CRITERIA: The trainee produces sound fillet welds in all positions. During and after each operation, welds are visually examined by the welder and accepted by the instructor. The objective is practiced in individual stages, beginning with the 1F (flat) position and ending with the 4F (overhead) position. The objective is practiced on a routine basis during the shielded metal arc welding portion of the program.

LEARNING ACTIVITIES:

The instructor shall:

1. Provide demonstrations related to all position fillet welding.
2. Provide instruction related to visual examination of fillet welds produced with the shielded metal arc welding process.
3. Provide training exercises related to 1F (flat), single and multiple pass fillet welding, on plain carbon steel, using E6010 or E6011, and E7018 electrodes.
4. Provide training exercises related to 2F (horizontal), single and multiple pass fillet welding, on plain carbon steel, using E6010 or E6011, and E7018 electrodes.
5. Provide training exercises related to 3F (vertical up), single and multiple pass fillet welding, on plain carbon steel, using E6010 or E6011, and E7018 electrodes.
6. Provide training exercises related to 4F (overhead), single and multiple pass fillet welding, on plain carbon steel, using E6010 or E6011, and E7018 electrodes.
7. Observe trainee following safe arc welding practices.
8. Observe trainee operating shielded metal arc welding equipment.
9. Visually inspect trainee's workmanship samples.
10. Provide instruction in welding procedures and workmanship related to this learning objective.
11. Keep training records reflecting results of all position fillet welding.

LEARNING OBJECTIVE #6 Make groove welds, all positions, on plain carbon steel, using the shielded metal arc welding process.

PERFORMANCE CONDITIONS: Provided with a period of demonstration, protective clothing and equipment, shielded metal arc welding equipment, accessories, E7018 electrodes, base metal or an assembly, hand tools,and a welding assignment, in the work area.

DESIRED BEHAVIOR: the trainee will make groove welds on plain carbon steel in all positions.

EVALUATION CRITERIA: The trainee produces sound groove welds in all positions. During and after each operation, welds were visually examined by the welder and accepted by the instructor. The objective is practiced in individual stages, beginning with the 1G (flat) position and ending with the 4G (overhead) position. The objective is practiced on a routine basis during the shielded metal arc welding portion of the program.

LEARNING ACTIVITIES:

The instructor shall:

1. Provide demonstrations related to all position groove welding.
2. Provide instruction related to visual examination of groove welds produced with the shielded metal arc welding process.
3. Provide training exercises related to 1G (flat), single and multiple pass groove welding, on plain carbon steel, using E7018 electrodes.
4. Provide training exercises related to 2G (horizontal), single and multiple pass groove welding, on plain carbon steel, using E7018 electrodes.
5. Provide training exercises related to 3G (vertical up), single and multiple pass groove welding, on plain carbon steel, using E7018 electrodes.
6. Provide training exercises related to 4G (overhead), single and multiple pass groove welding, on plain carbon steel, using E7018 electrodes.
7. Observe trainee following safe arc welding practices.
8. Observe trainee operating shielded metal arc welding equipment.
9. Visually inspect trainee's workmanship samples.
10. Provide instruction in welding procedures and workmanship related to this learning objective.
12. Keep training records reflecting results of all position groove welding.

LEARNING OBJECTIVE #7 Perform 2G - 3G limited thickness qualification tests on plain carbon steel plate, using the shielded metal arc welding process.

PERFORMANCE CONDITIONS: Provided with protective clothing and equipment, shielded metal arc welding equipment, accessories, E7018 electrodes, 3/8" thick plain carbon steel material, Welding Procedure Specification ANSI AWS B2.2.001, Drawing # AWS-6 (figure7), and hand tools, in the work area, with no assistance from the instructor,

DESIRED BEHAVIOR: the trainee will perform welder performance qualification testing.

EVALUATION CRITERIA: The trainee produces sound groove welds in the 2G (horizontal), and 3G (vertical up) positions. Test assemblies are prepared according to drawing specifications and approved by the test supervisor. In accordance with the requirements of AWS QC10, WPS ANSI/AWS B2.2.001, and Drawing #AWS-6, the trainee shall pass the fabrication, weld symbol interpretation and welding elements of performance qualifications for limited thickness bend testing.

LEARNING ACTIVITIES:

The instructor shall:

1. Provide demonstrations related to all position groove welding.
2. Provide instruction related to visual examination of groove welds produced with the shielded metal arc welding process.
3. Provide training exercises related to 2G (horizontal), multiple pass groove welding, on plain carbon steel, using E7018 electrodes.
4. Provide training exercises related to 3G (vertical up), multiple pass groove welding, on plain carbon steel, using E7018 electrodes.
5. Observe trainee following safe arc welding practices.
6. Observe trainee operating shielded metal arc welding equipment.
7. Visually inspect trainee's workmanship samples.
8. Provide instruction in welding procedure and performance qualification related to this learning objective.
9. Prepare trainee for the fabrication, weld symbol interpretation and 2G (horizontal) and 3G (vertical) groove welding elements of performance qualifications for limited thickness bend testing.
10. Administer performance qualification testing upon completion of training in accordance with the requirements of AWS QC10.
11. Keep training records reflecting results of 2G (horizontal) and 3G (vertical up) groove welding performance qualifications for limited thickness bend testing.

NOTE: THIS LEARNING OBJECTIVE IS DELIVERED AT THE END OF THE TRAINING PROGRAM AS PART OF ENTRY LEVEL WELDER CERTIFICATION.

3.3.3.2 UNIT #2: GAS METAL ARC WELDING (GMAW-S, GMAW)

LEARNING OBJECTIVE #1: Perform safety inspections of equipment and accessories.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, safety inspection guidelines, protective clothing and equipment, hand tools, gas metal arc welding equipment and accessories, a single or mixed shielding gas supply with equipment and accessories, in the work area.

DESIRED BEHAVIOR: the trainee performs safety inspections of protective clothing and equipment, hand tools, gas metal arc welding equipment and accessories, shielding gas equipment and accessories, and the work area.

EVALUATION CRITERIA: The trainee's protective clothing and equipment, hand tools, gas metal arc welding equipment and accessories, shielding gas equipment and accessories, and work area meet safety requirements. Hazard warnings are communicated to others in the immediate area prior to the start of gas metal arc welding operations. In the course of daily operations the trainee is observed following safe practices. The objective is performed as required during the gas metal arc welding portion of the program. In accordance with the requirements of AWS QC10, the trainee shall pass the arc welding safety portion of a summative closed book examination from the related sections of ANSI Z49.1 *Safety in Welding, Cutting and Allied Processes.*

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide safety tour and orientation to gas metal arc welding equipment and accessories, and shielding gas equipment and accessories.
3. Provide demonstrations related to ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes*, Part II- Specific Processes, 11. Arc Welding and Cutting Equipment Safety.
4. Provide demonstrations related to routine safety inspections of protective equipment and clothing, gas metal arc welding equipment and accessories, shielding gas equipment and accessories, required tools and the work area.
5. Provide instruction related to ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes*, Part II - Specific Processes, 11. Arc Welding and Cutting Equipment Safety.
6. Reinforce previous instruction from ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes*, Part I - General Aspects.
7. Introduce related terms and definitions.
8. Observe trainee conducting safety inspections.
9. Observe trainee following safe practices.
10. Observe trainee using proper terms and definitions.
11. Develop and administer formative or diagnostic tests relevant to safe arc welding practices.
12. Prepare trainee for the arc welding safety portion of a summative closed book examination from the related sections of ANSI Z49.1 *Safety in Welding, Cutting and Allied Processes.*
13. Keep records reflecting successful completion of GMAW safe practices training.

LEARNING OBJECTIVE #2: Make minor external repairs to gas metal arc welding equipment and accessories.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, and repair materials, equipment or tools, in the work area.

DESIRED BEHAVIOR: the trainee will make minor external repairs to gas metal arc welding equipment and accessories, and shielding gas equipment and accessories.

EVALUATION CRITERIA: Repairs to gas metal arc welding equipment and accessories, and shielding gas equipment and accessories are made in accordance with the manufacturer's recommendations and the institution's repair policy. The correct repair materials, equipment or tools are selected. The assignment is completed in a timely manner. The objective is performed as required during the gas metal arc welding portion of the program. In accordance with the requirements of AWS QC10, the trainee shall pass the gas metal arc welding component identification portion of a summative closed book examination from the related sections of ANSI/AWS C5.6, *Recommended Practices for Gas Metal Arc Welding*.

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide demonstrations related to gas metal arc welding component identification.
3. Provide demonstrations related to shielding gas equipment and accessory component identification.
4. Provide instruction related to gas metal arc welding component identification.
5. Provide instruction related to shielding gas equipment and accessory component identification.
6. Provide demonstrations related to minor external repairs on gas metal arc welding equipment and accessories.
7. Provide demonstrations related to minor external repairs on shielding gas equipment and accessories.
8. Provide instruction related to minor external repairs to gas metal arc welding equipment and accessories.
9. Provide instruction related to minor external repairs to shielding gas equipment and accessories.
10. Introduce related terms and definitions.
11. Provide trainee with repair assignments when required.
12. Observe trainee following safe repair practices.
13. Observe trainee using proper terms and definitions.
14. Develop and administer formative or diagnostic tests relevant to gas metal arc welding, shielding gas equipment and accessory component identification.
15. Prepare trainee for the gas metal arc welding component identification portion of a summative closed book examination from the related sections of ANSI/AWS C5.6, *Recommended Practices for Gas Metal Arc Welding*.
16. Keep training records reflecting results of gas metal arc welding, shielding gas equipment, and accessory component identification.

LEARNING OBJECTIVE #3 Set up for gas metal arc welding operations on plain carbon steel.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, verbal or written instructions, protective clothing and equipment, hand tools, gas metal arc welding equipment and accessories, a mixed or single shielding gas supply with equipment and accessories, E70S-X electrodes, and base metal, in the work area,

DESIRED BEHAVIOR: the trainee will set up and prepare to perform gas metal arc welding operations on plain carbon steel.

EVALUATION CRITERIA: The trainee is prepared to weld. Verbal or written instructions are understood. Protective clothing and equipment are suitable for job requirements. The proper hand tools, equipment, base metal, shielding gas, and filler metals are selected. Gas metal arc welding equipment is set up and adjusted to the proper voltage, wire feed speed, and polarity. Shielding gas equipment is set up and adjusted to the proper flow rate. Parts are assembled and preheated according to job requirements. The objective is performed on a routine basis during the gas metal arc welding portion of the program. In accordance with the requirements of AWS QC10, the trainee shall pass the gas metal arc welding principles of operation, and filler metal identification/selection portion of a summative closed book examination from the related sections of ANSI/AWS C5.6, *Recommended Practices for Gas Metal Arc Welding* and ANSI/AWS A5.18, *Specification for Carbon Steel Filler Metals for Gas-shielded Arc Welding*.

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide demonstrations related to gas metal arc welding equipment and accessory set up.
3. Provide demonstrations related to shielding gas equipment and accessory set up.
4. Provide instruction in gas metal arc welding principles of operation.
5. Provide instruction in shielding gases relevant to the gas metal arc welding process.
6. Provide instruction in gas metal arc welding filler metal identification and selection.
7. Introduce related terms and definitions.
8. Provide trainee with practice setting up gas metal arc welding equipment and accessories.
9. Provide trainee with practice setting up shielding gas equipment and accessories.
10. Observe trainee following safe practices.
11. Observe trainee using proper terms and definitions.
12. Observe trainee setting up gas metal arc welding equipment and accessories.
13. Observe trainee setting up shielding gas equipment and accessories.
14. Develop and administer formative or diagnostic tests relevant to gas metal arc welding principles of operation, filler metal classification and selection.
15. Prepare trainee for the gas metal arc welding principles of operation, and filler metal identification/selection portion of a summative closed book examination from the related sections of ANSI/AWS C5.6, *Recommended Practices for Gas Metal Arc Welding* and ANSI/AWS A5.18, *Specification for Carbon Steel Filler Metals for Gas-shielded Arc Welding*.
16. Keep training records reflecting results of gas metal arc welding equipment set up, principles of operation, and filler metal identification/selection.

LEARNING OBJECTIVE #4 Operate gas metal arc welding equipment.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, verbal or written instructions, protective clothing and equipment, hand tools, gas metal arc welding equipment and accessories, various shielding gases with equipment and accessories, .035 or .045 E70S-X electrodes, base metal, and a welding assignment, in the work area.

DESIRED BEHAVIOR: the trainee will perform short circuit and spray transfer gas metal arc welding operations.

EVALUATION CRITERIA: The trainee's welding was completed as required by the welding assignment. During and after the operation, welds are visually examined by the trainee and accepted by the instructor. The objective is performed on a routine basis during the gas metal arc welding portion of the program. In accordance with the requirements of AWS QC10, the trainee shall pass the gas metal arc principles of operation and common process variables portion of a summative closed book examination from the related section of ANSI/AWS C5.6, *Recommended Practices for Gas Metal Arc Welding.*

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide demonstrations related to gas metal arc welding equipment operations.
3. Provide instruction related to gas metal arc welding principles of operation.
4. Provide instruction related to common process variables for gas metal arc welding.
5. Provide training exercises related to gas metal arc welding equipment operation.
6. Provide training exercises related to starting and maintaining an arc on plain carbon steel.
7. Provide training exercises related to flat, multiple pass, multi-directional, surfacing welds, on plain carbon steel, using short circuit transfer,.035 or .045 diameter E70S-X electrodes and a CO_2 or 75%argon/25%CO_2 shielding gas.
8. Provide training exercises related to flat, multiple pass, multi-directional, surfacing welds, on plain carbon steel, using spray transfer, .035 or .045 diameter E70S-X electrodes and an argon/2%-5%Oxygen shielding gas.
9. Observe trainee following safe arc welding practices.
10. Observe trainee operating gas metal arc welding equipment.
11. Visually inspect trainee's workmanship samples.
12. Develop and administer formative or diagnostic tests relevant to gas metal arc welding principles of operation and common process variables.
13. Prepare trainee for the gas metal arc welding principles of operation and common process variables portion of a summative closed book examination from the related sections of ANSI/AWS C5.6, *Recommended Practices for Gas Metal Arc Welding.*
14. Keep training records reflecting results of gas metal arc welding equipment principles of operation, common process variables and performance exercises.

LEARNING OBJECTIVE #5 Make fillet welds, all positions, on plain carbon steel, using the gas metal arc welding process, with short circuit transfer.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, verbal or written instructions, protective clothing and equipment, hand tools, gas metal arc welding equipment and accessories, a CO2 or 75%argon/25%CO2 shielding gas supply with equipment and accessories, .035 or .045 diameter E70S-X electrodes, base metals, and a welding assignment, in the work area,

DESIRED BEHAVIOR: the trainee will make fillet welds on plain carbon steel in all positions using short circuit transfer.

EVALUATION CRITERIA: The trainee produces sound fillet welds in all positions. During and after each operation, welds are visually examined by the welder and accepted by the instructor. The objective is practiced in individual stages, beginning with the 1F (flat) position and ending with the 4F (overhead) position. The objective is practiced on a routine basis during the gas metal arc welding portion of the program. In accordance with the requirements of AWS QC10, WPS AWS-1-GMAW-S, and Drawing #AWS-1 (figure2), the trainee shall pass the fabrication, weld symbol interpretation, and welding elements of workmanship qualifications for visual examination.

LEARNING ACTIVITIES:

The instructor shall:

1. Provide demonstrations related to all position fillet welding using short circuit transfer.
2. Provide instruction related to visual examination of fillet welds produced with the gas metal arc welding process.
3. Provide training exercises related to 1F (flat), single and multiple pass fillet welding, on plain carbon steel, using short circuit transfer, applicable electrodes, and shielding gas(es).
4. Provide training exercises related to 2F (horizontal), single and multiple pass fillet welding, on plain carbon steel, using short circuit transfer, applicable electrodes, and shielding gas(es).
5. Provide training exercises related to 3F (vertical up), single and multiple pass fillet welding, on plain carbon steel, using short circuit transfer, applicable electrodes, and shielding gas(es).
6. Provide training exercises related to 4F (overhead), single and multiple pass fillet welding, on plain carbon steel, using short circuit transfer, applicable electrodes, and shielding gas(es).
7. Observe trainee following safe arc welding practices.
8. Observe trainee operating gas metal arc welding equipment.
9. Visually inspect trainee's workmanship samples.
10. Provide instruction in welding procedures and workmanship qualification related to this learning objective
11. Prepare trainee for the fabrication, weld symbol interpretation and all position fillet welding elements of workmanship qualifications for visual examination.
12. Administer workmanship qualification testing at the end of gas metal arc welding instruction in accordance with the requirements of AWS QC10.
13. Keep training records reflecting results of all position fillet welding and workmanship qualification for visual examination.

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LEARNING OBJECTIVE #6 Make groove welds, all positions, on plain carbon steel using the gas metal arc welding process, with short circuit process.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, verbal or written instructions, protective clothing and equipment, hand tools, gas metal arc welding equipment and accessories, a CO2 or 75%argon/25%CO2 shielding gas supply with equipment and accessories, .035 or .045 diameter E70S-X electrodes, base metals, and a welding assignment, in the work area.

DESIRED BEHAVIOR: the trainee will make groove welds on plain carbon steel in all positions using short circuit transfer.

EVALUATION CRITERIA: The trainee produces sound groove welds in all positions. During and after each operation, welds are visually examined by the welder and accepted by the instructor. The objective is practiced in individual stages, beginning with the 1G (flat) position and ending with the 4G (overhead) position. The objective is practiced on a routine basis during the gas metal arc welding portion of the program. In accordance with the requirements of AWS QC10, WPS AWS-1-GMAW-S, and Drawing #AWS-1(figure2), the trainee shall pass the fabrication, weld symbol interpretation, and welding elements of workmanship qualifications for visual examination.

LEARNING ACTIVITIES:

The instructor shall:

1. Provide demonstrations related to all position groove welding using short circuit transfer.
2. Provide instruction related to visual examination of groove welds produced with the gas metal arc welding process.
3. Provide training exercises related to 1G (flat), single and multiple pass groove welding, on plain carbon steel, using short circuit transfer, applicable electrodes, and shielding gas(es).
4. Provide training exercises related to 2G (horizontal), single and multiple pass groove welding, on plain carbon steel, using short circuit transfer, applicable electrodes, and shielding gas(es).
5. Provide training exercises related to 3G (vertical up), single and multiple pass groove welding, on plain carbon steel, using short circuit transfer, applicable electrodes, and shielding gas(es).
6. Provide training exercises related to 4G (overhead), single and multiple pass groove welding, on plain carbon steel, using short circuit transfer, applicable electrodes, and shielding gas(es).
7. Observe trainee following safe arc welding practices.
8. Observe trainee operating gas metal arc welding equipment.
9. Visually inspect trainee's workmanship samples.
10. Provide instruction in welding procedures and workmanship qualification related to this learning objective.
11. Prepare trainee for the fabrication, weld symbol interpretation and the overhead position groove welding elements of workmanship qualifications for visual examination.
12. Administer workmanship qualification testing at the end of gas metal arc welding instruction in accordance with the requirements of AWS QC10.
13. Keep training records reflecting results of all position groove welding and workmanship qualification for visual examination.

LEARNING OBJECTIVE #7 Make 1F - 2F fillet welds, on plain carbon steel, using the gas metal arc welding process, with spray transfer.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, verbal or written instructions, protective clothing and equipment, hand tools, gas metal arc welding equipment and accessories, an argon/2%-5%Oxygen shielding gas supply with equipment and accessories, .035 or .045 diameter E70S-X electrodes, base metals, and a welding assignment, in the work area,

DESIRED BEHAVIOR: the trainee will make fillet welds on plain carbon steel, in the 1F (flat) and 2F (horizontal) position, using spray transfer.

EVALUATION CRITERIA: The trainee produces sound fillet welds in the flat and horizontal positions. During and after each operation, welds are visually examined by the welder and accepted by the instructor. The objective is practiced in individual stages, beginning with the 1F (flat) position and ending with the 2F (horizontal) position. The objective is practiced on a routine basis during the gas metal arc welding portion of the program. In accordance with the requirements of AWS QC10, WPS AWS-2-GMAW, and Drawing #AWS-2 (figure 3), the trainee shall pass the fabrication, weld symbol interpretation, and welding elements of workmanship qualifications for visual examination.

LEARNING ACTIVITIES:

The instructor shall:

1. Provide demonstrations related to 1F - 2F fillet welds using spray transfer.
2. Provide instruction related to visual examination of fillet welds produced with the gas metal arc welding process.
3. Provide training exercises related to 1F (flat), single and multiple pass fillet welding, on plain carbon steel, using spray transfer, applicable electrodes, and shielding gas(es).
4. Provide training exercises related to 2F (horizontal), single and multiple pass fillet welding, on plain carbon steel, using spray transfer, applicable electrodes, and shielding gas(es).
7. Observe trainee following safe arc welding practices.
8. Observe trainee operating gas metal arc welding equipment.
9. Visually inspect trainee's workmanship samples.
10. Provide instruction in welding procedures and workmanship qualification related to this learning objective.
11. Prepare trainee for the fabrication, weld symbol interpretation and 1F (flat) and 2F (horizontal) fillet welding elements of workmanship qualifications for visual examination.
12. Administer workmanship qualification testing at the end of gas metal arc welding instruction in accordance with the requirements of AWS QC10.
13. Keep training records reflecting results of 1F (flat) and 2F (horizontal) position fillet welding and workmanship qualification for visual examination.

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LEARNING OBJECTIVE #8 Make 1G (flat) groove welds, on plain carbon steel, using the gas metal arc welding process, with spray transfer.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, verbal or written instructions, protective clothing and equipment, hand tools, gas metal arc welding equipment and accessories, an argon/2%-5%Oxygen shielding gas supply with equipment and accessories, .035 or .045 diameter E70S-X electrodes, base metals, and a welding assignment, in the work area.

DESIRED BEHAVIOR: the trainee will make groove welds on plain carbon steel, in the 1G (flat) position, using spray transfer.

EVALUATION CRITERIA: The trainee produces sound groove welds in the 1G (flat) position. During and after each operation, welds are visually examined by the welder and accepted by the instructor. The objective is practiced on a routine basis during the gas metal arc welding portion of the program. In accordance with the requirements of AWS QC10, WPS AWS-2-GMAW, and Drawing #AWS-2 (figure 3), the trainee shall pass the fabrication, weld symbol interpretation and welding elements of workmanship qualifications for visual examination.

LEARNING ACTIVITIES:

The instructor shall:

1. Provide demonstrations related to all position groove welding using spray transfer.
2. Provide instruction related to visual examination of groove welds produced with the gas metal arc welding process.
3. Provide training exercises related to 1G (flat), single and multiple pass groove welding, on plain carbon steel, using spray transfer, applicable electrodes, and shielding gas(es).
4. Observe trainee following safe arc welding practices.
5. Observe trainee operating gas metal arc welding equipment.
6. Visually inspect trainee's workmanship samples.
7. Provide instruction in welding procedures and workmanship qualification related to this learning objective.
8. Prepare trainee for the fabrication, weld symbol interpretation and the flat position groove welding elements of workmanship qualifications for visual examination.
9. Administer workmanship qualification testing at the end of gas metal arc welding instruction in accordance with the requirements of AWS QC10.
10. Keep training records reflecting results of 1G (flat) groove welding and workmanship qualification for visual examination.

3.3.3.3 UNIT #3: FLUX CORED ARC WELDING (FCAW-G, FCAW)

LEARNING OBJECTIVE #1 Perform safety inspections of equipment and accessories.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, safety inspection guidelines, protective clothing and equipment, hand tools, flux cored arc welding equipment and accessories, shielding gas supply with equipment and accessories, in the work area.

DESIRED BEHAVIOR: the trainee performs safety inspections of protective clothing and equipment, hand tools, flux cored arc welding equipment and accessories, shielding gas equipment and accessories, and the work area.

EVALUATION CRITERIA: The trainee's protective clothing and equipment, hand tools, flux cored arc welding equipment and accessories, shielding gas equipment and accessories, and work area meet safety requirements. Hazard warnings are communicated to others in the immediate area prior to the start of flux cored arc welding operations. In the course of daily operations the trainee is observed following safe practices. The objective is performed as required during the flux cored arc welding portion of the program. In accordance with the requirements of AWS QC10, the trainee shall pass the arc welding safety portion of a summative closed book examination from the related sections of ANSI Z49.1 *Safety in Welding, Cutting and Allied Processes.*

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide safety tour and orientation for flux cored arc welding equipment and accessories, and shielding gas equipment and accessories.
3. Provide demonstrations related to ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes,* Part II- Specific Processes, 11. Arc Welding and Cutting Equipment Safety.
4. Provide demonstrations related to routine safety inspections of protective equipment and clothing, flux cored arc welding equipment and accessories, shielding gas equipment and accessories, required tools and the work area.
5. Provide instruction related to ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes,* Part II - Specific Processes, 11. Arc Welding and Cutting Equipment Safety.
6. Reinforce previous instruction from ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes,* Part I - General Aspects.
7. Introduce related terms and definitions.
8. Observe trainee conducting safety inspections.
9. Observe trainee following safe practices.
10. Observe trainee using proper terms and definitions.
11. Develop and administer formative or diagnostic tests relevant to safe arc welding practices.
12. Prepare trainee for the arc welding safety portion of a summative closed book examination from the related sections of ANSI Z49.1 *Safety in Welding, Cutting and Allied Processes.*
13. Keep records reflecting successful completion of FCAW safe practices training

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LEARNING OBJECTIVE #2 Make minor external repairs to flux cored arc welding equipment and accessories.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, and repair materials, equipment or tools, in the work area.

DESIRED BEHAVIOR: the trainee will make minor external repairs to flux cored arc welding equipment and accessories, and shielding gas equipment and accessories.

EVALUATION CRITERIA: The trainee's repairs to flux cored arc welding equipment and accessories, and shielding gas equipment and accessories are made in accordance with the manufacturer's recommendations and the institution's repair policy. The correct repair materials, equipment, or tools are selected. The assignment is completed in a timely manner. The objective is performed as required during the flux cored arc welding portion of the program. In accordance with the requirements of AWS QC10, the trainee shall pass the flux cored arc welding component identification portion of a summative closed book examination from the related sections of AWS Welding Handbook, Volume 2, Eighth Ed., *Welding Processes.*

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide demonstrations related to flux cored arc welding component identification.
3. Provide demonstrations related to shielding gas equipment and accessory component identification.
4. Provide instruction related to flux cored arc welding component identification.
5. Provide instruction related to shielding gas equipment and accessory component identification.
6. Provide demonstrations related to minor external repairs on flux cored arc welding equipment and accessories.
7. Provide demonstrations related to minor external repairs on shielding gas equipment and accessories.
8. Provide instruction related to minor external repairs to flux cored arc welding equipment and accessories.
9. Provide instruction related to minor external repairs to shielding gas equipment and accessories.
10. Introduce related terms and definitions.
11. Provide trainee with repair assignments when required.
12. Observe trainee following safe repair practices.
13. Observe trainee using proper terms and definitions.
14. Develop and administer formative or diagnostic tests relevant to flux cored arc welding, shielding gas equipment, and accessory component identification.
15. Prepare trainee for the flux cored arc welding component identification portion of a summative closed book examination from the related sections of AWS Welding Handbook, Volume 2, Eighth Ed., *Welding Processes.*
16. Keep training records reflecting results of flux cored arc welding, shielding gas equipment and accessory component identification.

LEARNING OBJECTIVE #3 Set up for flux cored arc welding operations on plain carbon steel.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, verbal or written instructions, protective clothing and equipment, hand tools, flux cored arc welding equipment and accessories, a mixed or single shielding gas supply (when required) with equipment and accessories, E71T-1 or E71T-11 electrodes, and base metals, in the work area.

DESIRED BEHAVIOR: the trainee will set up and prepare to perform self-shielded and gas-shielded flux cored arc welding operations on plain carbon steel.

EVALUATION CRITERIA: The trainee is prepared to weld. Verbal or written instructions are understood. Protective clothing and equipment are suitable for job requirements. The proper hand tools, equipment, base metal, shielding gas, and filler metals are selected. Flux cored arc welding equipment is set up and adjusted to the proper voltage, wire feed speed, and polarity. Shielding gas equipment is set up and adjusted to the proper flow rate. Parts are assembled and preheated according to job requirements. The objective is performed on a routine basis during the flux cored arc welding portion of the program. In accordance with the requirements of AWS QC10, the trainee shall pass the flux cored arc welding principles of operation, and filler metal identification/selection portion of a summative closed book examination from the related sections of AWS Welding Handbook, Volume 2, Eighth Ed., *Welding Processes* and ANSI/AWS A5.20, *Specification for Carbon Steel Electrodes for Flux Cored Arc Welding.*

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide demonstrations related to flux cored arc welding equipment and accessory set up.
3. Provide demonstrations related to shielding gas equipment and accessory set up.
4. Provide instruction in flux cored arc welding principles of operation.
5. Provide instruction in shielding gases for gas-shielded flux cored arc welding.
6. Provide instruction in the flux cored arc welding filler metal identification and selection.
7. Introduce related terms and definitions.
8. Provide trainee with practice setting up flux cored arc welding equipment and accessories.
9. Provide trainee with practice setting up shielding gas equipment and accessories.
10. Observe trainee following safe practices.
11. Observe trainee using proper terms and definitions.
12. Observe trainee setting up flux cored arc welding equipment and accessories.
13. Observe trainee setting up shielding gas equipment and accessories.
14. Develop and administer formative or diagnostic tests relevant to flux cored arc welding principles of operation and filler metal identification and selection.
15. Prepare trainee for the flux cored arc welding principles of operation, and filler metal identification/selection portion of a summative closed book examination from the related sections of AWS Welding Handbook, Volume 2, Eighth Ed., *Welding Processes* and ANSI/AWS A5.20, *Specification for Carbon Steel Electrodes for Flux Cored Arc Welding.*
16. Keep training records reflecting results of flux cored arc welding equipment set up, principles of operation, and filler metal identification/selection.

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LEARNING OBJECTIVE #4 Operate flux cored arc welding equipment.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, verbal or written instructions, protective clothing and equipment, hand tools, flux cored arc welding equipment and accessories, various shielding gases with equipment and accessories (when required), .035 or .045 diameter E71T-1 (gas shielded) or E71T-11 (self-shielded) electrodes, base metals, and a welding assignment, in the work area.

DESIRED BEHAVIOR: the trainee will perform self-shielded and gas-shielded flux cored arc welding operations.

EVALUATION CRITERIA: The trainee's welding was completed as required by the welding assignment. During and after the operation, welds are visually examined by the trainee and accepted by the instructor. The objective is performed on a routine basis during the flux cored arc welding portion of the program. In accordance with the requirements of AWS QC10, the trainee shall pass the flux cored arc welding principles of operation and common process variables portion of a summative closed book examination from the related section of AWS Welding Handbook, Volume 2, Eighth Ed., *Welding Processes*.

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide demonstrations related to flux cored arc welding equipment operations.
3. Provide instruction related to flux cored arc welding principles of operation.
4. Provide instruction related to common process variables for flux cored arc welding.
5. Provide training exercises related to flux cored arc welding equipment operation.
6. Provide demonstrations related to starting and maintaining an arc on plain carbon steel.
7. Provide training exercises related to starting and maintaining an arc on plain carbon steel.
8. Provide training exercises related to flat, multiple pass, multi-directional, surfacing welds, on plain carbon steel, using applicable self-shielded electrodes.
9. Provide training exercises related to flat, multiple pass, multi-directional, surfacing welds, on plain carbon steel, applicable gas-shielded electrodes, and CO_2 or 75%argon/25%CO_2 shielding gas(es).
10. Observe trainee following safe arc welding practices.
11. Observe trainee operating flux cored arc welding equipment.
12. Visually inspect trainee's workmanship samples.
13. Develop and administer formative or diagnostic tests relevant to flux cored arc welding principles of operation and common process variables.
14. Prepare trainee for the flux cored arc welding principles of operation and common process variables portion of a summative closed book examination from the related sections of AWS Welding Handbook, Volume 2, Eighth Ed., *Welding Processes*.
15. Keep training records reflecting results of flux cored arc welding equipment principles of operation, common process variables and performance exercises.

LEARNING OBJECTIVE #5 Make fillet welds, all positions, on plain carbon steel, using the flu cored arc welding process with self-shielded electrodes.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, verbal written instructions, protective clothing and equipment, hand tools, flux cored arc weldin equipment and accessories, .035 or .045 diameter E71T-11 electrodes, base metals, and a weldin assignment, in the work area,

DESIRED BEHAVIOR: the trainee will make fillet welds on plain carbon steel in all positions usin self-shielded flux cored arc welding electrodes.

EVALUATION CRITERIA: The trainee produces sound fillet welds in all positions. During and afte each operation, welds are visually examined by the welder and accepted by the instructor. The objective is practiced in individual stages, beginning with the 1F (flat) position and ending with the 4F (overhead) position. The objective is practiced on a routine basis during the self-shielded flux cored arc welding portion of the program. In accordance with the requirements of AWS QC10 WPS AWS-1-FCAW, and Drawing #AWS-1 (figure 2), the trainee shall pass the fabrication, weld symbol interpretation, and welding elements of workmanship qualifications for visual examination.

LEARNING ACTIVITIES:

The instructor shall:

1. Provide demonstrations related to all position fillet welding using self-shielded electrodes.
2. Provide instruction related to visual examination of fillet welds produced with the flux cored arc welding process.
3. Provide training exercises related to 1F (flat), single and multiple pass fillet welding, on plain carbon steel, using applicable self-shielded electrodes.
4. Provide training exercises related to 2F (horizontal), single and multiple pass fillet welding, on plain carbon steel, using applicable self-shielded electrodes.
5. Provide training exercises related to 3F (vertical up), single and multiple pass fillet welding, on plain carbon steel, using applicable self-shielded electrodes.
6. Provide training exercises related to 4F (overhead), single and multiple pass fillet welding, on plain carbon steel, using applicable self-shielded electrodes.
7. Observe trainee following safe arc welding practices.
8. Observe trainee operating flux cored arc welding equipment.
9. Visually inspect trainee's workmanship samples.
10. Provide instruction in welding procedures and workmanship qualification related to this learning objective.
11. Prepare trainee for the fabrication, weld symbol interpretation and all position fillet welding elements of workmanship qualifications for visual examination.
12. Administer workmanship qualification testing at the end of flux cored arc welding instruction in accordance with the requirements of AWS QC10.
13. Keep training records reflecting results of all position fillet welding and workmanship qualification for visual examination.

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LEARNING OBJECTIVE #6 Make groove welds, all positions, on plain carbon steel, using the flux cored arc welding process with self-shielded electrodes.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, verbal or written instructions, protective clothing and equipment, hand tools, gas metal arc welding equipment and accessories, .035 or .045 diameter E71T-11 electrodes, base metals, and a welding assignment, in the work area.

DESIRED BEHAVIOR: the trainee will make groove welds on plain carbon steel in all positions using self-shielded flux cored arc welding electrodes.

EVALUATION CRITERIA: The trainee produces sound groove welds in all positions. During and after each operation, welds are visually examined by the welder and accepted by the instructor. The objective is practiced in individual stages, beginning with the 1G (flat) position and ending with the 4G (overhead) position. The objective is practiced on a routine basis during the self-shielded flux cored arc welding portion of the program. In accordance with the requirements of AWS QC10,WPS AWS-1-FCAW, and Drawing #AWS-1 (figure 2), the trainee shall pass the fabrication, weld symbol interpretation and welding elements of workmanship qualifications for visual examination.

LEARNING ACTIVITIES:

The instructor shall:

1. Provide demonstrations related to all position groove welding using self-shielded electrodes.
2. Provide instruction related to visual examination of groove welds produced with the flux cored arc welding process.
3. Provide training exercises related to 1G (flat), single and multiple pass groove welding, on plain carbon steel, using applicable self-shielded electrodes.
4. Provide training exercises related to 2G (horizontal), single and multiple pass groove welding, on plain carbon steel, using applicable self-shielded electrodes.
5. Provide training exercises related to 3G (vertical up), single and multiple pass groove welding, on plain carbon steel, E71T-11 using applicable self-shielded electrodes.
6. Provide training exercises related to 4G (overhead), single and multiple pass groove welding, on plain carbon steel, using applicable self-shielded electrodes.
7. Observe trainee following safe arc welding practices.
8. Observe trainee operating flux cored arc welding equipment.
9. Visually inspect trainee's workmanship samples.
10. Provide instruction in welding procedures and workmanship qualification related to this learning objective.
11. Prepare trainee for the fabrication, weld symbol interpretation, and all position groove welding elements of workmanship qualifications for visual examination.
12. Administer workmanship qualification testing at the end of flux cored arc welding instruction in accordance with the requirements of AWS QC10.
13. Keep training records reflecting results of all position groove welding and workmanship qualification for visual examination.

LEARNING OBJECTIVE #7 Make fillet welds, all positions, on plain carbon steel, using the flux cored arc welding process with gas-shielded electrodes.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, verbal or written instructions, protective clothing and equipment, hand tools, flux cored arc welding equipment and accessories, a CO_2 or 75%argon/25%CO_2 shielding gas supply with equipment and accessories, .035 or .045 diameter E71T-1 electrodes, base metals, and a welding assignment, in the work area,

DESIRED BEHAVIOR: the trainee will make fillet welds on plain carbon steel in all positions using gas- shielded flux cored arc welding electrodes.

EVALUATION CRITERIA: The trainee produces sound fillet welds in all positions. During and after each operation, welds are visually examined by the welder and accepted by the instructor. The objective is practiced in individual stages, beginning with the 1F (flat) position and ending with the 4F (overhead) position. The objective is practiced on a routine basis during the gas-shielded flux cored arc welding portion of the program. In accordance with the requirements of AWS QC10, WPS ANSI/AWS B2.1.019 or B2.1.020, and Drawing #AWS-1 (figure 2), the trainee shall pass the fabrication, weld symbol interpretation and welding elements of workmanship qualifications for visual examination.

LEARNING ACTIVITIES:

The instructor shall:

1. Provide demonstrations related to all position fillet welding using gas-shielded electrodes.
2. Provide instruction related to visual examination of fillet welds produced with the flux cored arc welding process.
3. Provide training exercises related to 1F (flat), single and multiple pass fillet welding, on plain carbon steel, using applicable gas-shielded electrodes, and shielding gas(es).
4. Provide training exercises related to 2F (horizontal), single and multiple pass fillet welding, on plain carbon steel, using applicable gas-shielded electrodes, and shielding gas(es).
5. Provide training exercises related to 3F (vertical up), single and multiple pass fillet welding, on plain carbon steel, using applicable gas-shielded electrodes, and shielding gas(es).
6. Provide training exercises related to 4F (overhead), single and multiple pass fillet welding, on plain carbon steel, using applicable gas-shielded electrodes, and shielding gas(es).
7. Observe trainee following safe arc welding practices.
8. Observe trainee operating flux cored arc welding equipment.
9. Visually inspect trainee's workmanship samples.
10. Provide instruction in welding procedures and workmanship qualification related to this learning objective
11. Prepare trainee for the fabrication, weld symbol interpretation and all position fillet welding elements of workmanship qualifications for visual examination.
12. Administer workmanship qualification testing at the end of flux cored arc welding instruction in accordance with the requirements of AWS QC10.
13. Keep training records reflecting results of all position fillet welding and workmanship qualification for visual examination.

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LEARNING OBJECTIVE #8 Make groove welds, all positions, on plain carbon steel, using the flux cored arc welding process with gas-shielded electrodes.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, verbal or written instructions, protective clothing and equipment, hand tools, flux cored arc welding equipment and accessories, a CO_2 or 75%argon/25%CO_2 shielding gas supply with equipment and accessories, .035 or .045 diameter E71T-1 electrodes, base metals, and a welding assignment, in the work area.

DESIRED BEHAVIOR: the trainee will make groove welds on plain carbon steel in all positions using gas-shielded flux cored arc welding electrodes.

EVALUATION CRITERIA: The trainee produces sound groove welds in all positions. During and after each operation, welds are visually examined by the welder and accepted by the instructor. The objective is practiced in individual stages, beginning with the 1G (flat) position and ending with the 4G (overhead) position. The objective is practiced on a routine basis during the gas-shielded flux cored arc welding portion of the program. In accordance with the requirements of AWS QC10, WPS ANSI/AWS B2.1.019 or B2.1.020, and Drawing #AWS-1 (figure 2), the trainee shall pass the fabrication, weld symbol interpretation, and welding elements of workmanship qualifications for visual examination.

LEARNING ACTIVITIES:

The instructor shall:

1. Provide demonstrations related to all position groove welding using gas-shielded electrodes.
2. Provide instruction related to visual examination of groove welds produced with the flux cored arc welding process.
3. Provide training exercises related to 1G (flat), single and multiple pass groove welding, on plain carbon steel, using applicable gas-shielded electrodes, and shielding gas(es).
4. Provide training exercises related to 2G (horizontal), single and multiple pass groove welding, on plain carbon steel, using applicable gas-shielded electrodes, and shielding gas(es).
5. Provide training exercises related to 3G (vertical up), single and multiple pass groove welding, on plain carbon steel, using applicable gas-shielded electrodes, and shielding gas(es).
6. Provide training exercises related to 4G (overhead), single and multiple pass groove welding, on plain carbon steel, using applicable gas-shielded electrodes, and shielding gas(es).
7. Observe trainee following safe arc welding practices.
8. Observe trainee operating flux cored arc welding equipment.
9. Visually inspect trainee's workmanship samples.
10. Provide instruction in welding procedures and workmanship qualification related to this learning objective.
11. Prepare trainee for the fabrication, weld symbol interpretation and all position groove welding elements of workmanship qualifications for visual examination.
12. Administer workmanship qualification testing at the end of flux cored arc welding instruction in accordance with the requirements of AWS QC10.
13. Keep training records reflecting results of all position groove welding and workmanship qualification for visual examination.

3.3.3.4 UNIT #4: GAS TUNGSTEN ARC WELDING (GTAW)

LEARNING OBJECTIVE #1 Perform safety inspections of equipment and accessories.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, safety inspection guidelines, protective clothing and equipment, hand tools, gas tungsten arc welding equipment and accessories, a shielding gas supply with equipment and accessories, in the work area.

DESIRED BEHAVIOR: the trainee performs safety inspections of protective clothing and equipment, hand tools, gas tungsten arc welding equipment and accessories, shielding gas equipment and accessories, and the work area.

EVALUATION CRITERIA: The trainee's protective clothing and equipment, hand tools, gas tungsten arc welding equipment and accessories, shielding gas equipment and accessories, and work area meet safety requirements. Hazard warnings are communicated to others in the immediate area prior to the start of gas tungsten arc welding operations. In the course of daily operations the trainee is observed following safe practices. The objective is performed as required during the gas tungsten arc welding portion of the program. In accordance with the requirements of AWS QC10, the trainee shall pass the arc welding safety portion of a summative closed book examination from the related sections of ANSI Z49.1 *Safety in Welding, Cutting and Allied Processes*.

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide safety tour and orientation to gas tungsten arc welding equipment and accessories, and shielding gas equipment and accessories.
3. Provide demonstrations related to ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes*, Part II- Specific Processes, 11. Arc Welding and Cutting Equipment Safety.
4. Provide demonstrations related to routine safety inspections of protective equipment and clothing, gas tungsten arc welding equipment and accessories, shielding gas equipment and accessories, required tools and the work area.
5. Provide instruction related to ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes*, Part II - Specific Processes, 11. Arc Welding and Cutting Equipment Safety.
6. Reinforce previous instruction from ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes*, Part I - General Aspects.
7. Introduce related terms and definitions.
8. Observe trainee conducting safety inspections.
9. Observe trainee following safe practices.
10. Observe trainee using proper terms and definitions.
11. Develop and administer formative or diagnostic tests relevant to safe arc welding practices.
12. Prepare trainee for the arc welding safety portion of a summative closed book examination from the related sections of ANSI Z49.1 *Safety in Welding, Cutting and Allied Processes*.
13. Keep records reflecting successful completion of GTAW safe practices training.

LEARNING OBJECTIVE #2 Make minor external repairs to gas tungsten arc welding equipment and accessories.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, and repair materials, equipment or tools, in the work area,

DESIRED BEHAVIOR: the trainee will make minor external repairs to gas tungsten arc welding equipment and accessories, and shielding gas equipment and accessories.

EVALUATION CRITERIA: The trainee's repairs to gas tungsten arc welding equipment and accessories, and shielding gas equipment and accessories are made in accordance with the manufacturer's recommendations and the institution's repair policy. The correct repair materials, equipment or tools are selected. The assignment is completed in a timely manner. The objective is performed as required during the gas tungsten arc welding portion of the program. In accordance with the requirements of AWS QC10, the trainee shall pass the gas tungsten arc welding component identification portion of a summative closed book examination from the related sections of ANSI/AWS C5.5, *Recommended Practices for Gas Tungsten Arc Welding* and AWS Welding Handbook, Vol. 2, Eighth Ed., *Welding Processes.*

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide demonstrations related to gas tungsten arc welding component identification.
3. Provide demonstrations related to shielding gas equipment and accessory component identification.
4. Provide instruction related to gas tungsten arc welding component identification.
5. Provide instruction related to shielding gas equipment and accessory component identification.
6. Provide demonstrations related to minor external repairs on gas tungsten arc welding equipment and accessories.
7. Provide demonstrations related to minor external repairs on shielding gas equipment and accessories.
8. Provide instruction related to minor external repairs to gas tungsten arc welding equipment and accessories.
9. Introduce related terms and definitions
10. Provide trainee with repair assignments when required.
11. Observe trainee following safe repair practices.
12. Observe trainee using proper terms and definitions.
13. Develop and administer formative or diagnostic tests relevant to gas tungsten arc welding, shielding gas equipment, and accessory component identification.
14. Prepare trainee for the gas tungsten arc welding component identification portion of a summative closed book examination from the related sections of ANSI/AWS C5.5, *Recommended Practices for Gas Tungsten Arc Welding* and AWS Welding Handbook, Vol. 2, Eighth Ed., *Welding Processes.*
15. Keep training records reflecting results of gas tungsten arc welding, shielding gas equipment and accessory component identification.

LEARNING OBJECTIVE #3 Set up for gas tungsten arc welding operations on plain carbon steel, aluminum and stainless steel.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, verbal or written instructions, protective clothing and equipment, hand tools, gas tungsten arc welding equipment and accessories, an argon shielding gas supply with equipment and accessories, ER70S-X (plain carbon steel), ER3XX (stainless steel) and ER4043 (aluminum) filler metals, appropriate tungsten electrodes, and base metals, in the work area.

DESIRED BEHAVIOR: the trainee will set up and prepare to perform gas tungsten arc welding operations on plain carbon steel, aluminum and stainless steel.

EVALUATION CRITERIA: The trainee is prepared to weld. Verbal or written instructions are understood. Protective clothing and equipment are suitable for job requirements. The proper hand tools, equipment, base metal, shielding gas, and filler metals are selected. Gas tungsten arc welding equipment is set up and adjusted to the proper current and polarity. Shielding gas equipment is set up and adjusted to the proper flow rate. Parts are assembled and preheated according to job requirements. The objective is performed on a routine basis during the gas tungsten arc welding portion of the program. In accordance with the requirements of AWS QC10, the trainee shall pass the gas tungsten arc welding principles of operation, tungsten electrode and base/filler metal identification/selection portion of a summative closed book examination from the related sections of ANSI/AWS C5.5, *Recommended Practices for Gas Tungsten Arc Welding*, AWS Welding Handbook, Vol. 2, Eighth Ed., *Welding Processes*, ANSI/AWS A5.18, *Specification for Carbon Steel Filler Metals for Gas-shielded Arc Welding*, ANSI/AWS A5.9, *Specification for Bare Stainless Steel Welding Electrodes and Rods*, ANSI/AWS A5.10, *Specification for Bare Aluminum and Aluminum Alloy Welding Electrodes and Rods*, ANSI/AWS A5.12, *Specification for Tungsten and Tungsten Alloy Electrodes for Arc Welding and Cutting* and AWS Welding Handbook, Volume 1, Eighth Ed. *Welding Technology*.

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide demonstrations related to gas tungsten arc welding equipment and accessory set up.
3. Provide demonstrations related to shielding gas equipment and accessory set up.
4. Provide instruction in gas tungsten arc welding principles of operation.
5. Provide instruction in shielding gases as related to the gas tungsten arc welding process.
6. Provide instruction in aluminum and stainless steel shapes, and identification/selection.
7. Provide instruction in tungsten electrode identification/selection for plain carbon steel aluminum and stainless steel.
8. Provide instruction in the gas tungsten arc welding filler metal identification/selection for plain carbon steel, aluminum, and stainless steel.
9. Introduce related terms and definitions.

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10. Provide trainee with practice setting up gas tungsten arc welding equipment and accessories.
11. Provide trainee with practice setting up shielding gas equipment and accessories.
12. Observe trainee following safe practices.
13. Observe trainee using proper terms and definitions.
14. Observe trainee setting up gas tungsten arc welding equipment and accessories.
15. Observe trainee setting up shielding gas equipment and accessories.
16. Develop and administer formative or diagnostic tests relevant to gas tungsten arc welding principles of operation, tungsten electrode identification/selection, and base/filler metal identification/selection.
17. Prepare trainee for the gas tungsten arc welding principles of operation, aluminum and stainless steel weldability, and filler metal classification portion of a summative closed book examination from the related sections of ANSI/AWS C5.5, *Recommended Practices for Gas Tungsten Arc Welding*, AWS Welding Handbook, Volume 1, Eighth Ed., *Welding Technology*, Chapter 4, Welding Metallurgy, ANSI/AWS A5.18, *Specification for Carbon Steel Filler Metals for Gas-shielded Arc Welding*, ANSI/AWS A5.10, *Specification for Bare Aluminum and Aluminum Alloy Welding Electrodes and Rods*, ANSI/AWS A5.9, *Specification for Bare Stainless Steel Electrodes and Rods* and ANSI/AWS A5.12, *Specification for Tungsten and Tungsten Alloy Electrodes for Arc Welding and Cutting*.
18. Keep training records reflecting results of gas tungsten arc welding equipment set up, principles of operation, tungsten electrode identification/selection, and base/filler metal identification/selection.

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LEARNING OBJECTIVE #4 Operate gas tungsten arc welding equipment.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, verbal or written instructions, protective clothing and equipment, hand tools, gas tungsten arc welding equipment and accessories, an argon shielding gas supply with equipment and accessories, ER70S-X (plain carbon steel), ER3XX (stainless steel) and ER4043 (aluminum) filler metals, appropriate tungsten electrodes, and base metals, in the work area.

DESIRED BEHAVIOR: the trainee will perform gas tungsten arc welding operations.

EVALUATION CRITERIA: The trainee's welding was completed as required by the welding assignment. During and after the operation, welds were visually examined by the trainee and accepted by the instructor. The objective is performed on a routine basis during the gas tungsten arc welding portion of the program. In accordance with the requirements of AWS QC10, the trainee shall pass the gas tungsten arc welding principles of operation and common process variables portion of a summative closed book examination from the related section of ANSI/AWS C5.5, *Recommended Practices for Gas Tungsten Arc Welding* and AWS Welding Handbook, Vol. 2, Eighth Ed., *Welding Processes.*

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide demonstrations related to gas tungsten arc welding equipment operations.
3. Provide instruction related to gas tungsten arc welding principles of operation.
4. Provide instruction related to common process variables for gas tungsten arc welding.
5. Provide training exercises related to gas tungsten arc welding equipment operation.
6. Provide training exercises related to starting and maintaining an arc on plain carbon steel, using applicable filler metal, an EWTh-2 or EWCe-2 electrode, and shielding gas.
7. Provide training exercises related to starting and maintaining an arc on aluminum, using applicable filler metal, an EWP or EWZr electrode, and shielding gas.
8. Provide training exercises related to starting and maintaining an arc on stainless steel, using applicable filler metal, an EWTh-2 electrode, and shielding gas.
9. Provide training exercises related to flat, single pass, surfacing welds, on plain carbon steel, using applicable filler metal, an EWTh-2 or EWCe-2 electrode, and shielding gas.
10. Provide training exercises related to flat, single pass, surfacing welds, on aluminum, using applicable filler metal, an EWP or EWZr electrode, and shielding gas.
11. Provide training exercises related to flat, single pass, surfacing welds, on stainless steel, using applicable filler metal, an EWTh-2 or EWCe-2 electrode, and shielding gas.
12. Observe trainee following safe arc welding practices.
13. Observe trainee operating gas tungsten arc welding equipment.
14. Visually inspect trainee's workmanship samples.
15. Develop and administer formative or diagnostic tests relevant to gas tungsten arc welding principles of operation and common process variables.

16. Prepare trainee for the gas tungsten arc welding principles of operation and common process variables portion of a summative closed book examination from the related sections of ANSI/AWS C5.5, *Recommended Practices for Gas Tungsten Arc Welding* and AWS Welding Handbook, Vol. 2, Eighth Ed., *Welding Processes.*
17. Keep training records reflecting results of gas tungsten arc welding equipment principles of operation, common process variables, and performance exercises.

LEARNING OBJECTIVE #5 Make fillet welds, all positions, on plain carbon steel, using the gas tungsten arc welding process.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, verbal or written instructions, protective clothing and equipment, hand tools, gas tungsten arc welding equipment and accessories, an argon shielding gas supply with equipment and accessories, ER70S-X (plain carbon steel) filler metals, EWTh-2 or EWCe-2 tungsten electrodes, and base metals, in the work area,

DESIRED BEHAVIOR: the trainee will make fillet welds on plain carbon steel in all positions using the gas tungsten arc welding process.

EVALUATION CRITERIA: The trainee produces sound fillet welds in all positions. During and after each operation, welds are visually examined by the welder and accepted by the instructor. The objective is practiced in individual stages, beginning with the 1F (flat) position and ending with the 4F (overhead) position. The objective is practiced on a routine basis during the gas tungsten arc welding portion of the program. In accordance with the requirements of AWS QC10, WPS ANSI/AWS B2.1.008, and Drawing #AWS-3 (figure 4), the trainee shall pass the fabrication, weld symbol interpretation, and welding elements of workmanship qualifications for visual examination.

LEARNING ACTIVITIES:

The instructor shall:

1. Provide demonstrations related to all position fillet welding.
2. Provide instruction related to visual examination of fillet welds produced with the gas tungsten arc welding process.
3. Provide training exercises related to 1F (flat), fillet welding, on plain carbon steel, using applicable filler metal, tungsten electrode, and shielding gas.
4. Provide training exercises related to 2F (horizontal), fillet welding, on plain carbon steel, using applicable filler metal, tungsten electrode, and shielding gas.
5. Provide training exercises related to 3F (vertical up), fillet welding, on plain carbon steel, using applicable filler metal, tungsten electrode, and shielding gas.
6. Provide training exercises related to 4F (overhead), fillet welding, on plain carbon steel, using applicable filler metal, tungsten electrode, and shielding gas.
7. Observe trainee following safe arc welding practices.
8. Observe trainee operating gas tungsten arc welding equipment.
9. Visually inspect trainee's workmanship samples.
10. Provide instruction in welding procedures and workmanship qualification related to this learning objective.
11. Prepare trainee for the fabrication, weld symbol interpretation and all position fillet welding elements of workmanship qualifications for visual examination.
12. Administer workmanship qualification testing at the end of gas tungsten arc welding instruction in accordance with the requirements of AWS QC10.
13. Keep training records reflecting results of all position fillet welding and workmanship qualification for visual examination.

LEARNING OBJECTIVE #6 Make groove welds, all positions, on plain carbon steel, using the gas tungsten arc welding process.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, verbal or written instructions, protective clothing and equipment, hand tools, gas tungsten arc welding equipment and accessories, an argon shielding gas supply with equipment and accessories, ER70S-X (plain carbon steel) filler metals, EWTh-2 or EWCe-2 tungsten electrodes, and base metals, in the work area.

DESIRED BEHAVIOR: the trainee will make groove welds on plain carbon steel in all positions using the gas tungsten arc welding process.

EVALUATION CRITERIA: The trainee produces sound groove welds in all positions. During and after each operation, welds are visually examined by the welder and accepted by the instructor. The objective is practiced in individual stages, beginning with the 1G (flat) position and ending with the 4G (overhead) position. The objective is practiced on a routine basis during the gas tungsten arc welding portion of the program. In accordance with the requirements of AWS QC10, WPS ANSI/AWS B2.1.008, and Drawing #AWS-3 (figure 4), the trainee shall pass the fabrication, weld symbol interpretation, and welding elements of workmanship qualifications for visual examination.

LEARNING ACTIVITIES:

The instructor shall:

1. Provide demonstrations related to all position groove welding.
2. Provide instruction related to visual examination of groove welds produced with the gas tungsten arc welding process.
3. Provide training exercises related to 1G (flat), groove welding, on plain carbon steel, using applicable filler metal, tungsten electrode, and shielding gas.
4. Provide training exercises related to 2G (horizontal), groove welding, on plain carbon steel, using applicable filler metal, tungsten electrode, and shielding gas.
5. Provide training exercises related to 3G (vertical up), groove welding, on plain carbon steel, using applicable filler metal, tungsten electrode, and shielding gas.
6. Provide training exercises related to 4G (overhead), groove welding, on plain carbon steel, using applicable filler metal, tungsten electrode, and shielding gas.
7. Observe trainee following safe arc welding practices.
8. Observe trainee operating gas tungsten arc welding equipment.
9. Visually inspect trainee's workmanship samples.
10. Provide instruction in welding procedures and workmanship qualification related to this learning objective.
11. Prepare trainee for the fabrication, weld symbol interpretation and all position groove welding elements of workmanship qualifications for visual examination.
12. Administer workmanship qualification testing at the end of gas tungsten arc welding instruction in accordance with the requirements of AWS QC10.
13. Keep training records reflecting results of all position groove welding and workmanship qualification for visual examination.

LEARNING OBJECTIVE #7 Make 1F - 2F fillet welds, on aluminum, using the gas tungsten arc welding process.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, verbal or written instructions, protective clothing and equipment, hand tools, gas tungsten arc welding equipment and accessories, an argon shielding gas supply with equipment and accessories, ER4043 (aluminum) filler metals, EWP or EWZr tungsten electrodes, and base metals, in the work area.

DESIRED BEHAVIOR: the trainee will make fillet welds on aluminum in the 1F (flat) and 2F (horizontal) positions using the gas tungsten arc welding process.

EVALUATION CRITERIA: The trainee produces sound fillet welds in the 1F (flat) and 2F (horizontal) positions. During and after each operation, welds are visually examined by the welder and accepted by the instructor. The objective is practiced in individual stages, beginning with the 1F (flat) position and ending with the 2F (horizontal) position. The objective is practiced on a routine basis during the gas tungsten arc welding portion of the program. In accordance with the requirements of AWS QC10, WPS ANSI/AWS B2.1.015 or WPS AWS-5-GTAW, and Drawing #AWS-5 (figure 6), the trainee shall pass the fabrication, weld symbol interpretation, and welding elements of workmanship qualifications for visual examination.

LEARNING ACTIVITIES:

The instructor shall:

1. Provide demonstrations related to 1F (flat) and 2F (horizontal) position fillet welding.
2. Provide instruction related to visual examination of fillet welds produced with the gas tungsten arc welding process.
3. Provide training exercises related to 1F (flat), fillet welding, on aluminum, using applicable filler metal, tungsten electrode, and shielding gas.
4. Provide training exercises related to 2F (horizontal), fillet welding, on aluminum, using applicable filler metal, tungsten electrode, and shielding gas.
5. Observe trainee following safe arc welding practices.
6. Observe trainee operating gas tungsten arc welding equipment.
7. Visually inspect trainee's workmanship samples.
8. Provide instruction in welding procedures and workmanship qualification related to this learning objective.
9. Prepare trainee for the fabrication, weld symbol interpretation, 1F (flat) and 2F (horizontal) fillet welding elements of workmanship qualifications for visual examination.
10. Administer workmanship qualification testing at the end of gas tungsten arc welding instruction in accordance with the requirements of AWS QC10.
11. Keep training records reflecting results of 1F (flat) and 2F (horizontal) position fillet welding and workmanship qualification for visual examination.

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LEARNING OBJECTIVE #8 Make 1G groove welds, on aluminum, using the gas tungsten arc welding process.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, verbal or written instructions, protective clothing and equipment, hand tools, gas tungsten arc welding equipment and accessories, an argon shielding gas supply with equipment and accessories, ER4043 (aluminum) filler metals, EWP or EWZr tungsten electrodes, and base metals, in the work area.

DESIRED BEHAVIOR: the trainee will make groove welds on aluminum in the 1G (flat) position using the gas tungsten arc welding process.

EVALUATION CRITERIA: The trainee produces sound groove welds in the flat position. During and after each operation, welds are visually examined by the welder and accepted by the instructor. The objective is practiced on a routine basis during the gas tungsten arc welding portion of the program. In accordance with the requirements of AWS QC10, WPS ANSI/AWS B2.1.015 or WPS AWS-5-GTAW, and Drawing #AWS-5 (figure 6), the trainee shall pass the fabrication, weld symbol interpretation, and welding elements of workmanship qualifications for visual examination.

LEARNING ACTIVITIES:

The instructor shall:

1. Provide demonstrations related to 1G (flat) position groove welding.
2. Provide instruction related to visual examination of groove welds produced with the gas tungsten arc welding process.
3. Provide training exercises related to 1G (flat), groove welding, on aluminum, using applicable filler metal, tungsten electrode, and shielding gas.
4. Observe trainee following safe arc welding practices.
5. Observe trainee operating gas tungsten arc welding equipment.
6. Visually inspect trainee's workmanship samples.
7. Provide instruction in welding procedures and workmanship qualification related to this learning objective.
8. Prepare trainee for the fabrication, weld symbol interpretation, and 1G (flat) groove welding elements of workmanship qualifications for visual examination.
9. Administer workmanship qualification testing at the end of gas tungsten arc welding instruction in accordance with the requirements of AWS QC10.
10. Keep training records reflecting results of 1G (flat) position groove welding and workmanship qualification for visual examination.

LEARNING OBJECTIVE #9 Make 1F - 3F fillet welds, on stainless steel, using the gas tungsten arc welding process.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, verbal and written instructions, protective clothing and equipment, hand tools, gas tungsten arc welding equipment and accessories, an argon shielding gas supply with equipment and accessories, ER3XX (stainless steel) filler metals, EWTh-2 or EWCe-2 tungsten electrodes, and base metals, in the welding area.

DESIRED BEHAVIOR: the trainee will make fillet welds on stainless steel in the 1F (flat), 2F (horizontal) and 3F (vertical up) positions using the gas tungsten arc welding process.

EVALUATION CRITERIA: The trainee produces sound fillet welds in the 1F (flat), 2F (horizontal) and 3F (vertical up) positions. During and after each operation, welds are visually examined by the welder and accepted by the instructor. The objective is practiced in individual stages, beginning with the 1F (flat) position and ending with the 3F (vertical up) position. The objective is practiced on a routine basis during the gas tungsten arc welding portion of the program. In accordance with the requirements of AWS QC10, WPS ANSI/AWS B2.1.009, and Drawing #AWS-4 (figure 5), the trainee shall pass the fabrication, weld symbol interpretation, and welding elements of workmanship qualifications for visual examination.

LEARNING ACTIVITIES:

The instructor shall:

1. Provide demonstrations related to 1F (flat), 2F (horizontal) and 3F (vertical up) position fillet welding.
2. Provide instruction related to visual examination of fillet welds produced with the gas tungsten arc welding process.
3. Provide training exercises related to 1F (flat), fillet welding, on stainless steel, using applicable filler metal, tungsten electrode, and shielding gas.
4. Provide training exercises related to 2F (horizontal), fillet welding, on stainless steel, using applicable filler metal, tungsten electrode, and shielding gas.
5. Provide training exercises related to 3F (vertical up), fillet welding, on stainless steel, using applicable filler metal, tungsten electrode, and shielding gas.
6. Observe trainee following safe arc welding practices.
7. Observe trainee operating gas tungsten arc welding equipment.
8. Visually inspect trainee's workmanship samples.
9. Provide instruction in welding procedures and workmanship qualification related to this learning objective.
10. Prepare trainee for the fabrication, weld symbol interpretation, 1F (flat), 2F (horizontal) and 3F (vertical up) fillet welding elements of workmanship qualifications for visual examination.
11. Administer workmanship qualification testing at the end of gas tungsten arc welding instruction in accordance with the requirements of AWS QC10.
12. Keep training records reflecting results of 1F (flat), 2F (horizontal) and 3F (vertical up) position fillet welding and workmanship qualification for visual examination.

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LEARNING OBJECTIVE #10 Make 1G - 2G groove welds, on stainless steel, using the gas tungsten arc welding process.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, verbal or written instructions, protective clothing and equipment, hand tools, gas tungsten arc welding equipment and accessories, an argon shielding gas supply with equipment and accessories, ER3XX (stainless steel) filler metals, EWTh-2 or EWCe-2 tungsten electrodes, and base metals, in the work area.

DESIRED BEHAVIOR: the trainee will make groove welds on stainless steel in the 1G (flat) and 2G (horizontal) positions using the gas tungsten arc welding process.

EVALUATION CRITERIA: Sound groove welds are produced in the 1G (flat) and 2G (horizontal) positions. During and after each operation, welds are visually examined by the welder and accepted by the instructor. The objective is practiced in individual stages, beginning with the 1G (flat) position and ending with the 2G (horizontal) position. The objective is practiced on a routine basis during the gas tungsten arc welding portion of the program. In accordance with the requirements of AWS QC10, WPS ANSI/AWS B2.1.009, and Drawing #AWS-4 (figure 5), the trainee shall pass the fabrication, weld symbol interpretation, and welding elements of workmanship qualifications for visual examination.

LEARNING ACTIVITIES:

The instructor shall:

1. Provide demonstrations related to 1G (flat) and 2G (horizontal) position groove welding.
2. Provide instruction related to visual examination of groove welds produced with the gas tungsten arc welding process.
3. Provide training exercises related to 1G (flat), groove welding, on stainless steel, using applicable filler metal, tungsten electrode, and shielding gas.
4. Provide training exercises related to 2G (horizontal), groove welding, on stainless steel, using applicable filler metal, tungsten electrode, and shielding gas.
5. Observe trainee following safe arc welding practices.
6. Observe trainee operating gas tungsten arc welding equipment.
7. Visually inspect trainee's workmanship samples.
8. Provide instruction in welding procedures and workmanship qualification related to this learning objective.
9. Prepare trainee for the fabrication, weld symbol interpretation, 1G (flat) and 2G (horizontal) groove welding elements of workmanship qualifications for visual examination.
10. Administer workmanship qualification testing at the end of gas tungsten arc welding instruction in accordance with the requirements of AWS QC10.
11. Keep training records reflecting results of 1G (flat) and 2G (horizontal) position groove welding and workmanship qualification for visual examination.

3.3.4 COURSE D: OXYFUEL GAS CUTTING PRINCIPLES & PRACTICES

3.3.4.1 UNIT #1: MANUAL OXYFUEL GAS CUTTING (OFC)

LEARNING OBJECTIVE #1 Perform safety inspections of equipment and accessories.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, safe inspection guidelines, protective clothing and equipment, manual OFC equipment and accessori oxygen/fuel gas supply systems and accessories, and hand tools, in the work area.

DESIRED BEHAVIOR: the trainee performs safety inspections of protective equipment and clothir oxyfuel gas cutting equipment and accessories, oxygen/fuel gas supply systems and accessori required tools and the work area.

EVALUATION CRITERIA: The trainee's protective equipment and clothing, manual oxygen/fu equipment and accessories, oxygen/fuel gas supply systems and accessories, hand tools, and wo area meet safety requirements. Hazard warnings are communicated to others in the immediate ar prior to the start of oxygen/fuel cutting operations. In the course of daily operations the trainee observed following safe practices. The objective is performed as required during the length of t program. In accordance with the requirements of AWS QC10, the trainee shall pass the oxygen fu cutting safety portion of a summative closed book examination from the related sections of AN Z49.1 *Safety in Welding, Cutting and Allied Processes*.

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documen specified for this learning objective.
2. Provide safety tour and orientation to oxyfuel gas cutting supply systems, equipment ar accessories.
3. Provide demonstrations related to ANSI Z49.1, *Safety in Welding, Cutting and Allied Processe* Part II- Specific Processes, 10. Oxyfuel Gas Welding and Cutting Safety.
4. Provide demonstrations related to routine safety inspections of protective equipment ar clothing, oxyfuel gas cutting supply systems, equipment and accessories, required tools and th work area.
5. Provide instruction related to ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes*, Pa II- Specific Processes, 10. Oxyfuel Gas Welding and Cutting Safety.
6. Reinforce previous instruction from ANSI Z49.1, *Safety in Welding, Cutting and Allie Processes*, Part I - General Aspects.
7. Introduce related terms and definitions.
8. Observe trainee conducting safety inspections.
9. Observe trainee following safe practices.
10. Observe trainee using proper terms and definitions.
11. Develop and administer formative or diagnostic tests relevant to safe oxyfuel gas cuttin practices.
12. Prepare trainee for the oxyfuel gas cutting safety portion of a summative closed book examination from the related sections of ANSI Z49.1 *Safety in Welding, Cutting and Allie Processes*.
13. Keep records reflecting successful completion of OFC safe practices training.

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LEARNING OBJECTIVE #2 Make minor external repairs to manual oxyfuel equipment and accessories.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, and repair materials, equipment or tools, in the work area.

DESIRED BEHAVIOR: the trainee will make minor external repairs to manual oxyfuel gas cutting equipment and accessories.

EVALUATION CRITERIA: The trainee's repairs on manual oxyfuel gas cutting equipment and accessories, oxygen/fuel gas supply systems and accessories are made in accordance with the manufacturer's recommendations and the institution's repair policy. The correct repair materials, equipment or tools are selected. The assignment is completed in a timely manner. The objective is performed as required during the length of the program. In accordance with the requirements of AWS QC10, the trainee shall pass the oxyfuel gas cutting component identification portion of a summative closed book examination from the related sections of ANSI/AWS C4.2, *Operator's Manual for Oxyfuel Gas Cutting*.

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide demonstrations related to oxyfuel gas cutting supply systems, equipment, and accessory component identification.
3. Provide demonstrations related to oxyfuel gas cutting supply systems, equipment, and accessory component identification.
4. Provide demonstrations related to minor external repairs on oxyfuel gas cutting supply systems, equipment, and accessories.
5. Introduce related terms and definitions
6. Provide trainee with repair assignments when required.
7. Observe trainee following safe repair practices.
8. Observe trainee using proper terms and definitions.
9. Develop and administer formative or diagnostic tests relevant to manual oxyfuel gas cutting supply systems, equipment, and accessory component identification.
10. Prepare trainee for the manual oxyfuel gas cutting component identification portion of a summative closed book examination from the related sections of ANSI/AWS C4.2, *Operator's Manual for Oxyfuel Gas Cutting*
11. Keep training records reflecting results of oxyfuel gas cutting supply systems, equipment, and accessory component identification.

LEARNING OBJECTIVE #3 Set up for manual oxyfuel gas cutting operations on plain carbon steel.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, verbal written instructions, protective clothing and equipment, manual oxyfuel gas cutting equipment a accessories, oxygen/fuel gas supply systems and accessories, hand tools and base metal, in the wo area,

DESIRED BEHAVIOR: the trainee will set up for manual oxyfuel gas cutting operations on pla carbon steel.

EVALUATION CRITERIA: The trainee is prepared to cut. Verbal or written instructions are understoo Protective clothing and equipment are suitable for job requirements. The proper hand tool equipment, and base metal are selected. Manual oxyfuel gas cutting equipment and accessorie oxygen/fuel gas supply systems and accessories are set up and adjusted to the proper pressure. Part are positioned and preheated according to job requirements. The objective is performed on a routin basis during the length of the program. In accordance with the requirements of AWS QC10, th trainee shall pass the oxyfuel gas cutting principles of operation portion of a summative closed boo examination from the related sections of ANSI/AWS C4.2, *Operator's Manual for Oxyfuel Ga Cutting.*

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide demonstrations related to oxyfuel gas cutting supply systems, equipment and accessory set up.
3. Provide instruction in manual oxyfuel gas cutting principles of operation.
4. Introduce related terms and definitions.
5. Provide trainee with practice setting up oxyfuel gas cutting supply systems, equipment and accessories.
6. Observe trainee following safe practices.
7. Observe trainee using proper terms and definitions.
8. Observe trainee setting up oxyfuel gas cutting supply systems, equipment and accessories.
9. Develop and administer formative or diagnostic tests relevant to manual oxyfuel gas cutting principles of operation.
10. Prepare trainee for the oxyfuel gas cutting principles of operation portion of a summative closed book examination from the related sections of ANSI/AWS C4.2, *Operator's Manual for Oxyfuel Gas Cutting.*
11. Keep training records reflecting results of manual oxyfuel gas cutting set up, and principles of operation.

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LEARNING OBJECTIVE #4 Operate manual oxyfuel gas cutting equipment.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, protective clothing and equipment, manual oxyfuel gas cutting equipment and accessories, oxygen/fuel gas supply systems and accessories, hand tools, base metal and a cutting assignment, in the work area.

DESIRED BEHAVIOR: the trainee will perform manual oxyfuel gas cutting operations.

EVALUATION CRITERIA: The trainee's cutting is completed as required by the cutting assignment. During and after the operation cut surfaces are visually examined by the trainee and accepted by the instructor. The objective is performed on a routine basis during the length of the program. In accordance with the requirements of AWS QC10, the trainee shall pass the oxyfuel gas cutting principles of operation and common process variables portion of a summative closed book examination from the related sections of ANSI/AWS C4.2, *Operator's Manual for Oxyfuel Gas Cutting*.

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide demonstrations related to oxyfuel gas cutting equipment operation.
3. Provide instruction related to oxyfuel gas cutting equipment operation.
4. Provide instruction related to common process variables for manual oxyfuel gas cutting.
5. Provide training exercises related to oxyfuel gas cutting equipment operation.
6. Provide training exercises related to lighting and adjusting the oxyfuel gas cutting torch.
7. Observe trainee following safe manual oxyfuel gas cutting practices.
8. Observe trainee operating manual oxyfuel gas cutting equipment.
9. Visually inspect trainee's workmanship samples.
10. Develop and administer formative or diagnostic tests relevant to manual oxyfuel gas cutting principles of operation.
11. Prepare trainee for the manual oxyfuel gas cutting principles of operation portion of a summative closed book examination from the related sections of ANSI/AWS C4.2, *Operator's Manual for Oxyfuel Gas Cutting*.
12. Keep training records reflecting results of manual oxyfuel gas cutting principles of operation and performance exercises.

LEARNING OBJECTIVE #5 Perform straight cutting operations on plain carbon steel, using the manual oxyfuel gas cutting process.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, protective clothing and equipment, manual oxyfuel gas cutting equipment, accessories, oxygen/fuel gas supply systems and accessories, hand tools, base metal and a cutting assignment, in the work area.

DESIRED BEHAVIOR: the trainee will make straight cuts on plain carbon steel.

EVALUATION CRITERIA: The trainee produces a straight production cut surface. During and after each operation cut surfaces are visually examined by the welder and accepted by the instructor. The objective is performed on a routine basis during the length of the program. In accordance with the requirements of AWS QC10, the trainee shall pass the drawing interpretation and cutting elements of workmanship qualifications for visual examination.

LEARNING ACTIVITIES:

The instructor shall:

1. Provide demonstrations related to straight cutting operations using manual oxyfuel gas cutting equipment.
2. Provide instruction related to visual examination of flame cut edges and surfaces.
3. Provide training exercises related to straight cutting operations on plain carbon steel, using manual oxyfuel gas cutting equipment.
4. Observe trainee following safe oxyfuel gas cutting practices.
5. Observe trainee operating manual oxyfuel gas cutting equipment.
6. Visually inspect trainee's workmanship samples.
7. Provide instruction in cutting procedures related to this learning objective.
8. Prepare trainee for the fabrication, elements of workmanship qualifications for visual examination and bend testing.
9. Keep training records reflecting results of straight cutting and workmanship qualification for visual examination.

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LEARNING OBJECTIVE #6 Perform shape cutting operations on plain carbon steel, using the manual oxyfuel gas cutting process.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, protective clothing and equipment, manual oxyfuel gas cutting equipment and accessories, oxygen/fuel gas supply systems and accessories, hand tools, base metal and a cutting assignment, in the work area.

DESIRED BEHAVIOR: the trainee will make shape cuts on plain carbon steel.

EVALUATION CRITERIA: The trainee's cut shapes have a production cut surface appearance. During and after each operation, cut surfaces are visually examined by the welder and accepted by the instructor. The objective is performed on a routine basis during the length of the program. In accordance with the requirements of AWS QC10, the trainee shall pass the drawing interpretation and cutting elements of workmanship qualifications for visual examination.

LEARNING ACTIVITIES:

The instructor shall:

1. Provide demonstrations related to shape cutting operations using manual oxyfuel gas cutting equipment.
2. Provide instruction related to visual examination of flame cut edges and surfaces.
3. Provide training exercises related to shape cutting operations on plain carbon steel, using manual oxyfuel gas cutting equipment.
4. Observe trainee following safe oxyfuel gas cutting practices.
5. Observe trainee operating manual oxyfuel gas cutting equipment.
6. Visually inspect trainee's workmanship samples.
7. Provide instruction in cutting procedures related to this learning objective.
8. Prepare trainee for the fabrication, elements of workmanship qualifications for visual examination and bend testing.
9. Keep training records reflecting results of shape cutting and workmanship qualification for visual examination.

LEARNING OBJECTIVE #7 Perform bevel cutting operations on plain carbon steel, using the manual oxyfuel gas cutting process.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, protective clothing and equipment, manual oxyfuel gas cutting equipment and accessories, oxygen/fuel gas supply systems and accessories, hand tools, base metal and a cutting assignment, in the work area.

DESIRED BEHAVIOR: the trainee will make bevel cuts on plain carbon steel.

EVALUATION CRITERIA: The trainee produces a beveled production cut surface. During and after each operation, cut surfaces are visually examined by the welder and accepted by the instructor. The objective is performed on a routine basis during the length of the program. In accordance with the requirements of AWS QC10, the trainee shall pass the drawing interpretation and cutting elements of workmanship qualifications for visual examination.

LEARNING ACTIVITIES:

The instructor shall:

1. Provide demonstrations related to bevel cutting operations using manual oxyfuel gas cutting equipment.
2. Provide instruction related to visual examination of flame cut edges and surfaces.
3. Provide training exercises related to bevel cutting operations on plain carbon steel, using manual oxyfuel gas cutting equipment.
4. Observe trainee following safe oxyfuel gas cutting practices.
5. Observe trainee operating manual oxyfuel gas cutting equipment.
6. Visually inspect trainee's workmanship samples.
7. Provide instruction in cutting procedures related to this learning objective.
8. Prepare trainee for the fabrication, elements of workmanship qualifications for visual examination and bend testing.
9. Keep training records reflecting results of bevel cutting and workmanship qualification for visual examination.

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LEARNING OBJECTIVE #8 Remove weld metal on plain carbon steel using weld washing techniques, with the manual oxyfuel gas cutting process.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, protective clothing and equipment, manual oxyfuel gas cutting equipment and accessories, oxygen/fuel gas supply systems and accessories, hand tools, a base metal assembly and a cutting assignment, in the work area.

DESIRED BEHAVIOR: the trainee will use weld washing techniques to remove weld metal.

EVALUATION CRITERIA: The trainee removes all weld metal and the base metal is salvaged for further use. During and after each operation washed surfaces are visually examined by the welder and accepted by the instructor. The objective is practiced on a routine basis during the manual oxyfuel gas cutting portion of the program.

LEARNING ACTIVITIES:

The instructor shall:

1. Provide demonstrations related to weld washing operations using manual oxyfuel gas cutting equipment.
2. Provide instruction related to visual examination of flame cut edges and surfaces.
3. Provide training exercises related to weld washing operations and material salvage on plain carbon steel welded assemblies, using manual oxyfuel gas cutting equipment.
4. Observe trainee following safe oxyfuel gas cutting practices.
5. Observe trainee operating manual oxyfuel gas cutting equipment.
6. Visually inspect trainee's workmanship samples.
7. Provide instruction in cutting procedures related to this learning objective.
8. Keep training records reflecting results of weld washing techniques.

3.3.4.2 UNIT #2: MACHINE OXYFUEL GAS CUTTING (OFC) [TRACK BURNER]

LEARNING OBJECTIVE #1 Perform safety inspections of equipment and accessories.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, safety inspection guidelines, protective clothing and equipment, hand tools, manual oxyfuel gas cutting equipment and accessories, oxygen/fuel gas supply systems and accessories, in the work area,

DESIRED BEHAVIOR: the trainee performs safety inspections of protective equipment and clothing, the work area, hand tools, machine oxyfuel gas cutting [track burner] equipment and accessories, oxygen/fuel gas supply systems and accessories.

EVALUATION CRITERIA: The trainee's protective equipment and clothing, work area, hand tools, machine oxyfuel gas cutting [track burner] equipment and accessories, oxygen/fuel gas supply systems and accessories meet safety requirements. Hazard warnings are communicated to others in the immediate area prior to the start of oxyfuel gas cutting operations. In the course of daily operations, the trainee is observed following safe practices. The objective is performed as required during the length of the program. In accordance with the requirements of AWS QC10, the trainee shall pass the oxyfuel gas cutting safety portion of a summative closed book examination from the related sections of ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes.*

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide safety tour and orientation to machine oxyfuel gas cutting supply systems, equipment and accessories.
3. Provide demonstrations related to ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes,* Part II- Specific Processes, 10. Oxyfuel Gas Welding and Cutting Safety.
4. Provide demonstrations related to routine safety inspections of protective equipment and clothing, machine oxyfuel gas cutting supply systems, equipment and accessories, required tools, and the work area.
5. Provide instruction related to ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes,* Part II- Specific Processes, 10. Oxyfuel Gas Welding and Cutting Safety.
6. Reinforce previous instruction from ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes,* Part I - General Aspects.
7. Introduce related terms and definitions.
8. Observe trainee conducting safety inspections.
9. Observe trainee following safe practices.
10. Observe trainee using proper terms and definitions.
11. Develop and administer formative or diagnostic tests relevant to safe oxyfuel gas cutting practices.
12. Prepare trainee for the machine oxyfuel gas cutting safety portion of a summative closed book examination from the related sections of ANSI Z49.1 *Safety in Welding, Cutting and Allied Processes.*
13. Keep records reflecting successful completion of machine OFC safe practices training.

LEARNING OBJECTIVE #2 Make minor external repairs to equipment and accessories, using the machine oxyfuel gas cutting process [track burner].

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, repair materials, equipment or tools, in the work area.

DESIRED BEHAVIOR: the trainee will make minor external repairs to machine oxyfuel gas cutting [track burner] equipment and accessories, oxygen/fuel gas supply systems and accessories.

EVALUATION CRITERIA: The trainee's repairs on machine oxyfuel gas cutting [track burner] equipment and accessories, oxygen/fuel gas supply systems and accessories are made in accordance with the manufacturer's recommendations and the institution's repair policy. The correct repair materials, equipment, or tools are selected. The assignment is completed in a timely manner. The objective is performed as required during the length of the program. In accordance with the requirements of AWS QC10, the trainee shall pass the machine oxyfuel gas cutting [track burner] component identification portion of a summative closed book examination from the related sections of ANSI/AWS C4.2, *Operator's Manual for Oxyfuel Gas Cutting*.

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide demonstrations related to machine oxyfuel gas cutting supply systems, equipment and accessory component identification.
3. Provide demonstrations related to machine oxyfuel gas cutting supply systems, equipment and accessory component identification.
4. Provide demonstrations related to minor external repairs on machine oxyfuel gas cutting supply systems, equipment, and accessories.
5. Introduce related terms and definitions,
6. Provide trainee with repair assignments when required.
7. Observe trainee following safe repair practices.
8. Observe trainee using proper terms and definitions.
9. Develop and administer formative or diagnostic tests relevant to machine oxyfuel gas cutting supply systems, equipment, and accessory component identification.
10. Prepare trainee for the gas tungsten arc welding component identification portion of a summative closed book examination from the related sections of ANSI/AWS C4.2, *Operator's Manual for Oxyfuel Gas Cutting*
11. Keep training records reflecting results of machine oxyfuel gas cutting supply systems, equipment and accessory component identification.

LEARNING OBJECTIVE #3 Set up for machine oxyfuel gas cutting [track burner] operations on plain carbon steel.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, verbal or written instructions, protective clothing and equipment, machine oxyfuel gas cutting [track burner] equipment and accessories, oxygen/fuel gas supply systems and accessories, hand tools and base metal, in the work area,

DESIRED BEHAVIOR: the trainee will set up for machine oxyfuel gas cutting [track burner] operations on plain carbon steel.

EVALUATION CRITERIA: The trainee is prepared to cut. Verbal or written instructions are understood. Protective clothing and equipment are suitable for job requirements. The proper hand tools, equipment, and base metal are selected. Machine oxyfuel gas cutting [track burner] equipment and accessories, oxygen/fuel gas supply systems and accessories are set up, adjusted to the proper pressure and travel speed. Parts are positioned and preheated according to job requirements. The objective is performed on a routine basis during the length of the program. In accordance with the requirements of AWS QC10, the trainee shall pass the oxyfuel gas cutting principles of operation portion of a summative closed book examination from the related sections of ANSI/AWS C4.2, *Operator's Manual for Oxyfuel Gas Cutting.*

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide demonstrations related to machine oxyfuel gas cutting supply systems, equipment and accessory set up.
3. Provide instruction in machine oxyfuel gas cutting principles of operation as related to ANSI/AWS C4.2, *Operator's Manual for Oxyfuel Gas Cutting* and the manufacturer's recommendations.
4. Introduce related terms and definitions.
5. Provide trainee with practice setting up machine oxyfuel gas cutting supply systems, equipment and accessories.
6. Observe trainee following safe practices.
7. Observe trainee using proper terms and definitions.
8. Observe trainee setting up machine oxyfuel gas cutting supply systems, equipment and accessories.
9. Develop and administer formative or diagnostic tests relevant to machine oxyfuel gas cutting principles of operation.
10. Prepare trainee for the machine oxyfuel gas cutting principles of operation portion of a summative closed book examination from the related sections of ANSI/AWS C4.2, *Operator's Manual for Oxyfuel Gas Cutting.*
11. Keep training records reflecting results of machine oxyfuel gas cutting set up and principles of operation

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LEARNING OBJECTIVE #4 Operate machine oxyfuel gas cutting [track burner] equipment.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, protective clothing and equipment, machine oxyfuel gas cutting [track burner] equipment and accessories, oxygen/fuel gas supply systems and accessories, hand tools, base metal and a cutting assignment, in the work area.

DESIRED BEHAVIOR: the trainee will perform machine oxyfuel gas cutting [track burner] operations.

EVALUATION CRITERIA: The trainee's cutting was completed as required by the cutting assignment. During and after the operation, cut surfaces are visually examined by the trainee and accepted by the instructor. The objective is performed on a routine basis during the length of the program. In accordance with the requirements of AWS QC10, the trainee shall pass the oxyfuel gas cutting principles of operation, and common process variables portion of a summative closed book examination from the related sections of ANSI/AWS C4.2, *Operator's Manual for Oxyfuel Gas Cutting*.

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide demonstrations related to machine oxyfuel gas cutting equipment operations.
3. Provide instruction related to machine oxyfuel gas cutting equipment operation.
4. Provide instruction related to common process variables for machine oxyfuel gas cutting.
5. Provide training exercises related to machine oxyfuel gas cutting equipment operation.
6. Provide training exercises related to lighting and adjusting the machine oxyfuel gas cutting torch.
7. Observe trainee following safe oxyfuel gas cutting practices.
8. Observe trainee operating oxyfuel gas cutting equipment.
9. Visually inspect trainee's workmanship samples.
10. Develop and administer formative or diagnostic tests relevant to machine oxyfuel gas cutting principles of operation and common process variables.
11. Prepare trainee for the oxyfuel gas cutting principles of operation and common process variables portion of a summative closed book examination from the related sections of ANSI/AWS C4.2, *Operator's Manual for Oxyfuel Gas Cutting*.
12. Keep training records reflecting results of oxyfuel gas cutting equipment principles of operation, common process variables, and performance exercises.

LEARNING OBJECTIVE #5 Perform straight cutting operations on plain carbon steel, using the machine oxyfuel gas cutting process [track burner].

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, safety inspection guidelines, protective clothing and equipment, hand tools, arc cutting equipment and accessories, a compressed air supply and accessories, base metal and a cutting assignment, in the work area.

DESIRED BEHAVIOR: the trainee will make straight cuts on plain carbon steel using machine oxyfuel gas cutting [track burner] equipment.

EVALUATION CRITERIA: The trainee produces a straight production cut surface. During and after each operation, cut surfaces are visually examined by the welder and accepted by the instructor. The objective is performed on a routine basis during the length of the program. In accordance with the requirements of AWS QC10, the trainee shall pass the drawing interpretation and cutting elements of workmanship qualifications for visual examination.

LEARNING ACTIVITIES:

The instructor shall:

1. Provide demonstrations related to straight cutting operations using machine oxyfuel gas cutting equipment.
2. Provide instruction related to visual examination of flame cut edges and surfaces.
3. Provide training exercises related to straight cutting operations on plain carbon steel, using machine oxyfuel gas cutting equipment.
4. Observe trainee following safe oxyfuel gas cutting practices.
5. Observe trainee operating machine oxyfuel gas cutting equipment.
6. Visually inspect trainee's workmanship samples.
7. Provide instruction in cutting procedures related to this learning objective.
8. Prepare trainee for the fabrication, elements of workmanship qualifications for visual examination and bend testing.
9. Keep training records reflecting results of straight cutting and workmanship qualification for visual examination and bend testing.

LEARNING OBJECTIVE #6 Perform bevel cutting operations on plain carbon steel, using the machine oxyfuel gas cutting process [track burner].

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, protective clothing and equipment, machine oxyfuel gas cutting [track burner] equipment and accessories, oxygen/fuel gas supply systems and accessories, hand tools, base metal and a cutting assignment, in the work area.

DESIRED BEHAVIOR: the trainee will make bevel cuts on plain carbon steel using machine oxyfuel gas cutting [track burner] equipment.

EVALUATION CRITERIA: The trainee produces a beveled production cut surface. During and after each operation, cut surfaces are visually examined by the welder and accepted by the instructor. The objective is performed on a routine basis during the length of the program. In accordance with the requirements of AWS QC10, the trainee shall pass the drawing interpretation and cutting elements of workmanship qualifications for visual examination.

LEARNING ACTIVITIES:

The instructor shall:

1. Provide demonstrations related to bevel cutting operations using machine oxyfuel gas cutting equipment.
2. Provide instruction related to visual examination of flame cut edges and surfaces.
3. Provide training exercises related to bevel cutting operations on plain carbon steel, using machine oxyfuel gas cutting equipment.
4. Observe trainee following safe oxyfuel gas cutting practices.
5. Observe trainee operating machine oxyfuel gas cutting equipment.
6. Visually inspect trainee's workmanship samples.
7. Provide instruction in cutting procedures related to this learning objective.
8. Prepare trainee for the fabrication, elements of workmanship qualifications for visual examination and bend testing.
9. Keep training records reflecting results of bevel cutting and workmanship qualification for visual examination and bend testing.

3.3.5 COURSE E: ARC CUTTING PRINCIPLES & PRACTICES

3.3.5.1 UNIT #1 AIR CARBON ARC CUTTING (CAC-A)

LEARNING OBJECTIVE #1 Perform safety inspections of equipment and accessories.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, safety inspection guidelines, protective clothing and equipment, hand tools, air carbon arc cutting equipment and accessories, a compressed air supply and accessories, in the work area.

DESIRED BEHAVIOR: the trainee performs safety inspections of protective equipment and clothing, air carbon arc cutting equipment and accessories, the compressed air system and accessories, required tools and the work area.

EVALUATION CRITERIA: The trainee's protective equipment and clothing, work area, air carbon arc cutting equipment and accessories, the compressed air system and accessories, and required tools meet safety requirements. Hazard warnings are communicated to others in the immediate area prior to the start of air carbon arc cutting operations. In the course of daily operations the trainee is observed following safe practices. The objective is performed as required during the air carbon arc cutting portion of the program. In accordance with the requirements of AWS QC10, the trainee shall pass the arc cutting safety portion of a summative closed book examination from the related sections of ANSI Z49.1 *Safety in Welding, Cutting and Allied Processes.*

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide safety tour and orientation to air carbon arc cutting equipment and accessories, and compressed air supply equipment and accessories.
3. Provide demonstrations related to ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes,* Part II- Specific Processes, 11. Arc Welding and Cutting Equipment Safety.
4. Provide demonstrations related to routine safety inspections of protective equipment and clothing, air carbon arc cutting equipment and accessories, and compressed air supply equipment and accessories, required tools, and the work area.
5. Provide instruction related to ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes,* Part II - Specific Processes, 11. Arc Welding and Cutting Equipment Safety.
6. Reinforce previous instruction from ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes,* Part I - General Aspects.
7. Introduce related terms and definitions.
8. Observe trainee conducting safety inspections.
9. Observe trainee following safe practices.
10. Observe trainee using proper terms and definitions.
11. Develop and administer formative or diagnostic tests relevant to safe arc cutting practices.
12. Prepare trainee for the arc cutting safety portion of a summative closed book examination from the related sections of ANSI Z49.1 *Safety in Welding, Cutting and Allied Processes.*
13. Keep records reflecting successful completion of CAC-A safe practices training.

LEARNING OBJECTIVE #2 Make minor external repairs to air carbon arc cutting equipment and accessories.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, and repair materials, equipment or tools, in the work area.

DESIRED BEHAVIOR: the trainee will make minor external repairs to air carbon arc cutting equipment and accessories, and the compressed air system and accessories.

EVALUATION CRITERIA: The trainee's repairs on air carbon arc cutting equipment and accessories, and the compressed air system and accessories are made in accordance with the manufacturer's recommendations and the institution's repair policy. The correct repair materials, equipment or tools are selected. The assignment is completed in a timely manner. The objective is performed as required during the air carbon arc cutting portion of the program. In accordance with the requirements of AWS QC10, the trainee shall pass the air carbon arc cutting component identification portion of a summative closed book examination from the related sections of ANSI/AWS C5.3, *Recommended Practices for Air Carbon Arc Gouging and Cutting.*

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide demonstrations related to air carbon arc cutting component identification.
3. Provide demonstrations related to compressed air equipment component identification.
4. Provide instruction related to air carbon arc cutting component identification.
5. Provide instruction related to compressed air equipment component identification.
6. Provide demonstrations related to minor external repairs on air carbon arc cutting equipment and accessories.
7. Provide demonstrations related to minor external repairs on compressed air equipment and accessories.
8. Provide instruction related to minor external repairs to air carbon arc cutting equipment and accessories.
9. Provide instruction related to minor external repairs to compressed air equipment and accessories.
10. Introduce related terms and definitions.
11. Provide trainee with repair assignments when required.
12. Observe trainee following safe repair practices.
13. Observe trainee using proper terms and definitions.
14. Develop and administer formative or diagnostic tests relevant to air carbon arc cutting, compressed air equipment, and accessory component identification.
15. Prepare trainee for the air carbon arc cutting component identification portion of a summative closed book examination from the related sections of ANSI/AWS C5.3, *Recommended Practices for Air Carbon Arc Gouging and Cutting.*
16. Keep training records reflecting results of air carbon arc cutting, compressed air equipment component, and accessory identification.

LEARNING OBJECTIVE #3 Set up for manual air carbon arc cutting operations on plain carbon steel.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, protectiv clothing and equipment, hand tools, air carbon arc cutting equipment and accessories, a compress air supply and accessories, base metal, and a cutting assignment, in the work area,

DESIRED BEHAVIOR: the trainee will set up for gouging operations on plain carbon steel.

EVALUATION CRITERIA: The trainee is prepared to gouge. Verbal or written instructions a understood. Protective clothing and equipment are suitable for job requirements. The proper ha tools, equipment, base metal, and electrodes are selected. Air carbon arc cutting equipment a accessories are set up and adjusted to the proper current and polarity. The compressed air supp and accessories are set up and adjusted to the proper pressure. The objective is performed on routine basis during the air carbon arc cutting portion of the program. In accordance with t requirements of AWS QC10, the trainee shall pass the air carbon arc cutting principles of operati and electrode identification/selection portion of a summative closed book examination from t related sections of ANSI/AWS C5.3, *Recommended Practices for Air Carbon Arc Gouging a Cutting.*

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS docume specified for this learning objective.
2. Provide demonstrations related to air carbon arc cutting equipment and accessory set up.
3. Provide demonstrations related to compressed air equipment and accessory set up.
4. Provide instruction in air carbon arc cutting principles of operation.
5. Provide instruction in compressed air supply systems.
6. Provide instruction in air carbon arc cutting electrode selection.
7. Introduce related terms and definitions.
8. Provide trainee with practice setting up air carbon arc welding equipment and accessories.
9. Observe trainee following safe practices.
10. Observe trainee using proper terms and definitions.
11. Observe trainee setting up air carbon arc cutting equipment and accessories.
12. Observe trainee setting up compressed air equipment and accessories.
13. Develop and administer formative or diagnostic tests relevant to air carbon arc cutting princi of operation, and electrode identification/selection.
14. Prepare trainee for the air carbon arc cutting principles of operation, and electrode select portion of a summative closed book examination from the related sections of ANSI/AWS C *Recommended Practices for Air Carbon Arc Gouging and Cutting.*
15. Keep training records reflecting results of air carbon arc cutting equipment set up, principle operation, and electrode identification/selection.

LEARNING OBJECTIVE #4 Operate air carbon arc cutting equipment.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, protective clothing and equipment, hand tools, air carbon arc cutting equipment and accessories, a compressed air supply and accessories, base metal and a cutting assignment, in the work area.

DESIRED BEHAVIOR: the trainee will perform air carbon arc gouging operations.

EVALUATION CRITERIA: The trainee's gouging is completed as required by the cutting assignment. During and after the operation gouged, surfaces are visually examined by the trainee and accepted by the instructor. The objective is performed on a routine basis during the air carbon arc cutting portion of the program. In accordance with the requirements of AWS QC10, the trainee shall pass the air carbon arc cutting principles of operation and common process variables portion of a summative closed book examination from the related sections of ANSI/AWS C5.3, *Recommended Practices for Air Carbon Arc Gouging and Cutting.*

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide demonstrations related to air carbon arc cutting equipment operations.
3. Provide instruction related to air carbon arc cutting principles of operation.
4. Provide instruction related to common process variables for air carbon arc cutting.
5. Provide training exercises related to air carbon arc cutting equipment operation.
6. Provide training exercises related to starting and maintaining an arc on plain carbon steel.
7. Provide training exercises related to flat gouging on plain carbon steel.
8. Observe trainee following safe arc welding practices.
9. Observe trainee operating air carbon arc cutting equipment.
10. Visually inspect trainee's workmanship samples.
11. Develop and administer formative or diagnostic tests relevant to air carbon arc cutting principles of operation and common process variables.
12. Prepare trainee for the air carbon arc cutting principles of operation portion of a summative closed book examination from the related sections of ANSI/AWS C5.3, *Recommended Practices for Air Carbon Arc Gouging and Cutting.*
13. Keep training records reflecting results of air carbon arc cutting equipment principles of operation, common process variables, and performance exercises.

LEARNING OBJECTIVE #5 Perform metal removal operation on plain carbon steel, using the air carbon arc cutting process.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, protective clothing and equipment, hand tools, air carbon arc cutting equipment and accessories, a compressed air supply and accessories, base metal and a cutting assignment, in the work area,

DESIRED BEHAVIOR: the trainee will use gouging techniques to remove weld metal.

EVALUATION CRITERIA: The trainee removes all metal and the base metal is salvaged for further use. During and after each operation, gouged surfaces are visually examined by the welder and accepted by the instructor. The objective is practiced on a routine basis during the length of the program.

LEARNING ACTIVITIES:

The instructor shall:

1. Provide demonstrations related to metal removal operations using air carbon arc cutting equipment.
2. Provide instruction related to visual examination of arc cut surfaces.
3. Provide training exercises related to weld metal removal operations and material salvage on plain carbon steel welded assemblies, using air carbon arc cutting equipment.
4. Observe trainee following safe air carbon arc cutting practices.
5. Observe trainee operating air carbon arc cutting equipment.
6. Visually inspect trainee's workmanship samples.
7. Provide instruction in cutting procedures related to this learning objective.
8. Keep training records reflecting results of metal removal operations.

3.3.5.2 UNIT #2: PLASMA ARC CUTTING (PAC)

LEARNING OBJECTIVE #1: Perform safety inspections of equipment and accessories.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, safety inspection guidelines, protective clothing and equipment, hand tools, plasma arc cutting equipment and accessories, a compressed air or shielding gas supply and accessories, in the work area.

DESIRED BEHAVIOR: the trainee performs safety inspections of protective equipment and clothing, plasma arc cutting equipment and accessories, the compressed air system and accessories, required tools and the work area.

EVALUATION CRITERIA: The trainee's protective equipment and clothing, work area, plasma arc cutting equipment and accessories, the compressed air system and accessories or the shielding gas supply and accessories the and required tools meet safety requirements. Hazard warnings are communicated to others in the immediate area prior to the start of plasma arc cutting operations. In the course of daily operations, the trainee is observed following safe practices. The objective is performed as required during the plasma arc cutting portion of the program. In accordance with the requirements of AWS QC10, the trainee shall pass the arc cutting safety portion of a summative closed book examination from the related sections of ANSI Z49.1 *Safety in Welding, Cutting and Allied Processes*.

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide safety tour and orientation to plasma arc cutting equipment and accessories, and compressed air or shielding gas supply equipment and accessories.
3. Provide demonstrations related to ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes*, Part II - Specific Processes, 11. Arc Welding and Cutting Equipment Safety.
4. Provide demonstrations related to routine safety inspections of protective equipment and clothing, plasma arc cutting equipment and accessories, and compressed air supply or shielding gas equipment and accessories, required tools and the work area.
5. Provide instruction related to ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes*, Part II - Specific Processes, 11. Arc Welding and Cutting Equipment Safety.
6. Reinforce previous instruction from ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes*, Part I - General Aspects.
7. Introduce related terms and definitions.
8. Observe trainee conducting safety inspections.
9. Observe trainee following safe practices.
10. Observe trainee using proper terms and definitions.
11. Develop and administer formative or diagnostic tests relevant to safe arc cutting practices.
12. Prepare trainee for the arc cutting safety portion of a summative closed book examination from the related sections of ANSI Z49.1 *Safety in Welding, Cutting and Allied Processes*.
13. Keep records reflecting successful completion of PAC safe practices training.

LEARNING OBJECTIVE #2 Make minor external repairs to plasma arc cutting equipment and accessories.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, and repair materials, equipment or tools, in the work area,

DESIRED BEHAVIOR: the trainee will make minor external repairs to plasma arc cutting equipment and accessories, and the compressed air or shielding gas supply and accessories.

EVALUATION CRITERIA: The trainee's repairs on air plasma arc cutting equipment and accessories, and the compressed air or shielding gas system and accessories are made in accordance with the manufacturer's recommendations and the institution's repair policy. The correct repair materials, equipment or tools are selected. The assignment is completed in a timely manner. The objective is performed as required during the plasma arc cutting portion of the program. In accordance with the requirements of AWS QC10, the trainee shall pass the plasma arc cutting component identification portion of a summative closed book examination from the related sections of AWS Welding Handbook, Volume 2, Eighth Ed., *Welding Processes.*

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide demonstrations related to plasma arc cutting component identification.
3. Provide demonstrations related to compressed air or shielding gas equipment component identification.
4. Provide instruction related to plasma arc cutting component identification.
5. Provide instruction related to compressed air or shielding gas equipment component identification.
6. Provide demonstrations related to minor external repairs on plasma arc cutting equipment and accessories.
7. Provide demonstrations related to minor external repairs on compressed air or shielding gas equipment and accessories.
8. Provide instruction related to minor external repairs to plasma arc cutting equipment and accessories.
9. Provide instruction related to minor external repairs to compressed air or shielding gas equipment and accessories.
10. Introduce related terms and definitions.
11. Provide trainee with repair assignments when required.
12. Observe trainee following safe repair practices.
13. Observe trainee using proper terms and definitions.
14. Develop and administer formative or diagnostic tests relevant to plasma arc cutting and compressed air or shielding gas equipment and accessory component identification.
15. Prepare trainee for the plasma arc cutting component identification portion of a summative closed book examination from the related sections of AWS Welding Handbook, Volume 2, Eighth Ed., *Welding Processes.*
16. Keep training records reflecting results of plasma arc cutting and compressed air or shielding gas equipment and accessory component identification.

LEARNING OBJECTIVE #3 Set up for plasma arc cutting operations on plain carbon steel, aluminum, and stainless steel.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, protective clothing and equipment, hand tools, plasma arc cutting equipment and accessories, a compressed air or shielding gas supply and accessories, base metal and a cutting assignment, in the work area.

DESIRED BEHAVIOR: the trainee will set up for cutting operations on plain carbon steel, aluminum and stainless steel.

EVALUATION CRITERIA: The trainee is prepared to cut. Verbal or written instructions are understood. Protective clothing and equipment are suitable for job requirements. The proper hand tools, equipment, and base metal are selected. Plasma arc cutting equipment and accessories are set up and adjusted to the proper current and polarity. The compressed air or shielding gas supply and accessories are set up and adjusted to the proper pressure. The objective is performed on a routine basis during the plasma arc cutting portion of the program. In accordance with the requirements of AWS QC10, the trainee shall pass the plasma arc cutting principles of operation portion of a summative closed book examination from the related sections of AWS Welding Handbook, Volume 2, Eighth Ed., *Welding Processes*.

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide demonstrations related to plasma arc cutting equipment and accessory set up.
3. Provide demonstrations related to compressed air equipment and accessory set up.
4. Provide instruction in plasma arc cutting principles of operation.
5. Provide instruction in compressed air or shielding gas supply systems.
6. Provide instruction in plasma arc cutting electrode selection.
7. Introduce related terms and definitions.
8. Provide trainee with practice setting up plasma arc welding equipment and accessories.
9. Provide trainee with practice setting up compressed air equipment and accessories.
10. Observe trainee following safe practices.
11. Observe trainee using proper terms and definitions.
12. Observe trainee setting up plasma arc cutting equipment and accessories.
13. Observe trainee setting up compressed air or shielding gas equipment and accessories.
14. Develop and administer formative or diagnostic tests relevant to plasma arc cutting principles of operation.
15. Prepare trainee for the plasma arc cutting principles of operation portion of a summative closed book examination from the related sections of AWS Welding Handbook, Volume 2, Eighth Ed., *Welding Processes*.
16. Keep training records reflecting results of plasma arc cutting equipment set up and principles of operation.

LEARNING OBJECTIVE #4 Operate plasma arc cutting equipment.

PERFORMANCE: Provided with a period of instruction and demonstration, protective clothing and equipment, hand tools, plasma arc cutting equipment and accessories, a compressed air supply and accessories, base metal and a cutting assignment, in the work area,

DESIRED BEHAVIOR: the trainee performs plasma arc cutting operations.

EVALUATION CRITERIA: The trainee's cutting is completed as required by the cutting assignment. During and after the operation, cut surfaces are visually examined by the trainee and accepted by the instructor. The objective is performed on a routine basis during the plasma arc cutting portion of the program. In accordance with the requirements of AWS QC10, the trainee shall pass the plasma arc cutting principles of operation and common process variables portion of a summative closed book examination from the related sections sections of AWS Welding Handbook, Volume 2, Eighth Ed., *Welding Processes.*

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide demonstrations related to plasma arc cutting equipment operations.
3. Provide instruction related to plasma arc cutting principles of operation.
4. Provide instruction related to common process variables for plasma arc cutting.
5. Provide training exercises related to plasma arc cutting equipment operation.
6. Provide training exercises related to starting and maintaining an arc on plain carbon steel.
7. Provide training exercises related to starting a cut on plain carbon steel, aluminum, and stainless steel.
8. Observe trainee following safe arc welding practices.
9. Observe trainee operating plasma arc cutting equipment.
10. Visually inspect trainee's workmanship samples.
11. Develop and administer formative or diagnostic tests relevant to plasma arc cutting principles of operation and common process variables.
12. Prepare trainee for the plasma arc cutting principles of operation and common process variables portion of a summative closed book examination from the related sections of AWS Welding Handbook, Volume 2, Eighth Ed., *Welding Processes.*
13. Keep training records reflecting results of plasma arc cutting equipment principles of operation, common process variables, and performance exercises.

LEARNING OBJECTIVE #5 Perform shape cutting operations on plain carbon steel, aluminum and stainless steel, using the plasma arc cutting process.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, protective clothing and equipment, hand tools, plasma arc cutting equipment and accessories, a compressed air supply and accessories, base metal and a cutting assignment, in the work area,

DESIRED BEHAVIOR: the trainee will make shape cuts on plain carbon steel, aluminum, and stainless steel.

EVALUATION CRITERIA: The trainee's cut shapes have a production cut surface appearance. During and after each operation, cut surfaces are visually examined by the welder and accepted by the instructor. The objective is practiced on a routine basis during the plasma arc cutting portion of the program. In accordance with the requirements of AWS QC10, the trainee shall pass the drawing interpretation and cutting elements of workmanship qualifications for visual examination.

LEARNING ACTIVITIES:

The instructor shall:

1. Provide demonstrations related to shape cutting operations using plasma arc cutting equipment on plain carbon steel.
2. Provide demonstrations related to shape cutting operations using plasma arc cutting equipment on aluminum.
3. Provide demonstrations related to shape cutting operations using plasma arc cutting equipment on stainless steel.
4. Provide instruction related to visual examination of arc cut edges and surfaces.
5. Provide training exercises related to shape cutting operations on plain carbon steel, using plasma arc cutting equipment.
6. Provide training exercises related to shape cutting operations on aluminum, using plasma arc cutting equipment.
7. Provide training exercises related to shape cutting operations on stainless steel, using plasma arc cutting equipment.
8. Observe trainee following safe plasma arc cutting practices.
9. Observe trainee operating plasma arc cutting equipment.
10. Visually inspect trainee's workmanship samples.
11. Provide instruction in cutting procedures related to this learning objective.
12. Prepare trainee for the fabrication, elements of workmanship qualifications for visual examination.
13. Keep training records reflecting results of shape cutting and workmanship qualification for visual examination.

3.3.6 COURSE F: WELDING INSPECTION and TESTING PRINCIPLES

3.3.6.1 UNIT #1: VISUAL EXAMINATION

LEARNING OBJECTIVE #1: Examine cut surfaces and edges of prepared base metal parts.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, visual examination guidelines, verbal or written instructions, protective clothing and equipment, a cutting assignment and measuring tools, in the work area.

DESIRED BEHAVIOR: the trainee performs visual examination of cut surfaces and edges.

EVALUATION CRITERIA: Verbal or written instructions are understood. Cut surfaces are visually examined by the trainee and accepted by the instructor. The objective is performed on a routine basis during the length of the program. In accordance with the requirements of AWS QC10, the trainee shall pass the visual examination portion of a summative closed book examination from the related sections of ANSI/AWS C4.2, *Operator's Manual for Oxyfuel Gas Cutting* and AWS C4.1, *Criteria for Describing Oxygen-Cut Surfaces.*

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide demonstrations related to the visual examination of oxyfuel gas cut surfaces and edges.
3. Provide demonstrations related to the visual examination of arc cut surfaces and edges.
4. Provide instruction related to the visual examination of oxyfuel gas cut surfaces and edges.
5. Provide instruction related to the visual examination of arc cut surfaces and edges.
6. Provide instruction related to common cutting surface and edge discontinuities.
7. Provide training exercises related to the visual examination of oxyfuel gas cut surfaces and edges.
8. Provide training exercises related to the visual examination of arc cut surfaces and edges.
9. Observe trainee following safe visual examination practices.
10. Observe trainee performing visual examination.
11. Provide feedback to trainee about his/her visual examination diagnosis.
12. Develop and administer formative or diagnostic tests relevant to visual examination of cut surfaces and edges.
13. Prepare trainee for the visual examination portion of a summative closed book examination from the related sections of ANSI/AWS C4.2, *Operator's Manual for Oxyfuel Gas Cutting* and AWS C4.1, *Criteria for Describing Oxygen-Cut Surfaces.*
14. Keep training records reflecting results of visual examination of cut edges and surfaces.

LEARNING OBJECTIVE #2 Examine tack, root pass, intermediate layers and completed welds.

PERFORMANCE CONDITIONS: Provided with a period of instruction and demonstration, visual examination guidelines, verbal or written instructions, protective clothing and equipment, a welding assignment and measuring tools, in the work area,

DESIRED BEHAVIOR: the trainee performs visual examination of tack, intermediate layers, and completed welds.

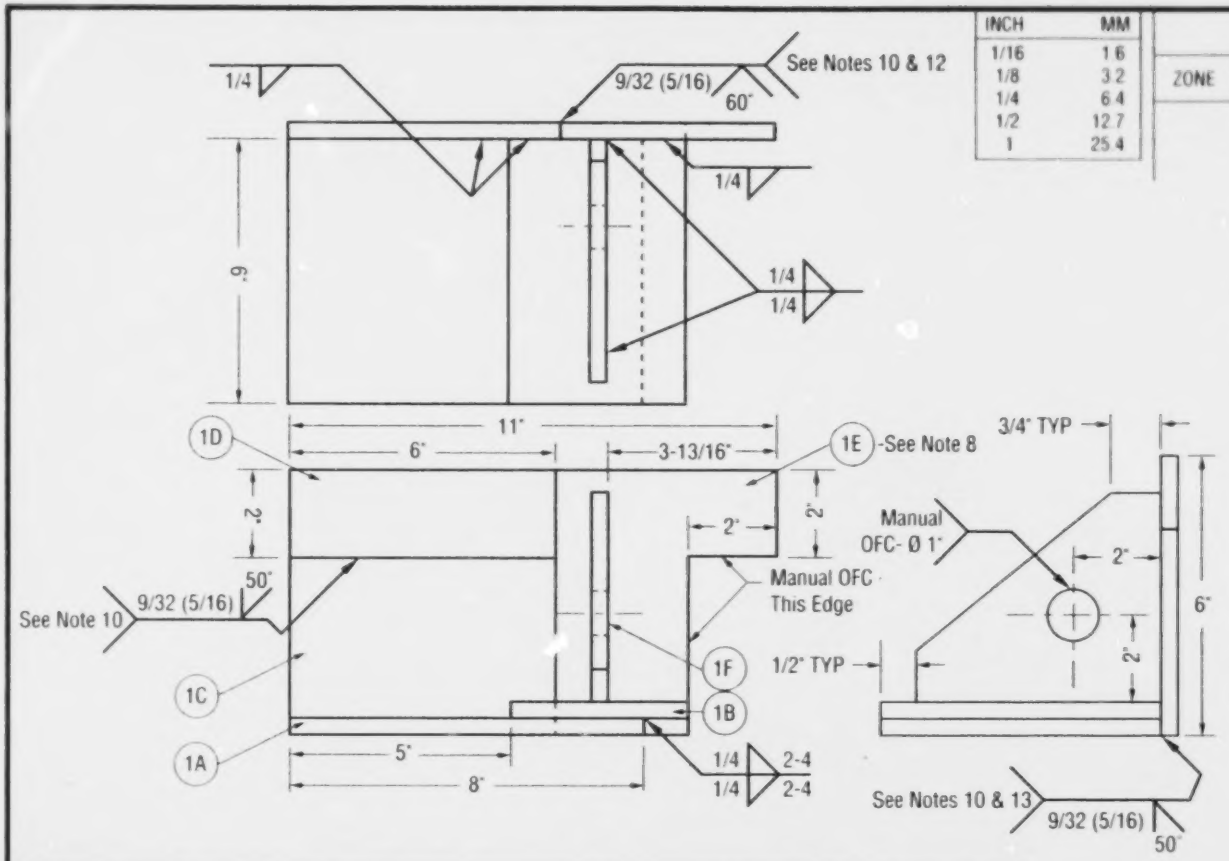
EVALUATION CRITERIA: Verbal or written instructions are understood. Welds made at various stages of the assignment are visually examined by the trainee and accepted by the instructor. The objective is performed on a routine basis during the length of the program. In accordance with the requirements of AWS QC10, the trainee shall pass the visual examination portion of a summative closed book examination from the related sections of ANSI/AWS B1.11, *Guide for the Visual Examination of Welds.*

LEARNING ACTIVITIES:

The instructor shall:

1. Ensure that existing or new training materials are in compliance with the AWS documents specified for this learning objective.
2. Provide demonstrations related to the visual examination of welds.
3. Provide instruction related to the visual examination of welds.
4. Provide instruction related to common weld discontinuities.
5. Provide training exercises related to the visual examination of welds.
6. Observe trainee following safe visual examination practices.
7. Observe trainee performing visual examination.
8. Provide feedback to trainee about his/her visual examination diagnosis.
9. Develop and administer formative or diagnostic tests relevant to visual examination of welds.
10. Prepare trainee for the visual examination portion of a summative closed book examination from the related sections of ANSI/AWS B1.11, *Guide for the Visual Examination of Welds.*
11. Keep training records reflecting results of visual examination of welds.

Figure 2 - GMAW-S, FCAW, FCAW-G Workmanship Qualification Test.



INCH	MM
1/16	1.6
1/8	3.2
1/4	6.4
1/2	12.7
1	25.4

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

NOTES

1. All dimensions U.S. customary unless otherwise specified.
2. 3/8" thickness plain carbon steel material
3. The welder shall prepare a bill of materials in U.S. customary units of measure prior to cutting.
4. The welder shall convert the above bill of materials to S.I. metric units of measure.
5. All parts may be mechanically cut or machine OFC unless indicated manual OFC.
6. All welds GMAW-S, FCAW-G or FCAW as applicable.
7. Fit and tack entire assembly on bench before attaching to positioning fixture arm.
8. Attach 2" x 2" extension tab of part 1E to positioning fixture arm. ALL WELDING DONE IN POSITION ACCORDING TO DRAWING ORIENTATION.
9. Employ boxing technique where applicable.
10. Partial penetration weld.
11. For GMAW-S use WPS AWS-1-GMAW-S.
    For FCAW-G use WPS B2.1-019 or WPS B2.1-020.
    For FCAW use WPS AWS-1-FCAW.
12. Weld joins Parts 1C and 1D to 1E.
13. Weld joins Parts 1C and 1E to 1A.
14. Visual examination in accordance with the requirements of AWS QC10, Table 1.

PART	No. REQD	SIZE	S.I. CONVERSION
1A			
1B			
1C			
1D			
1E			
1F			

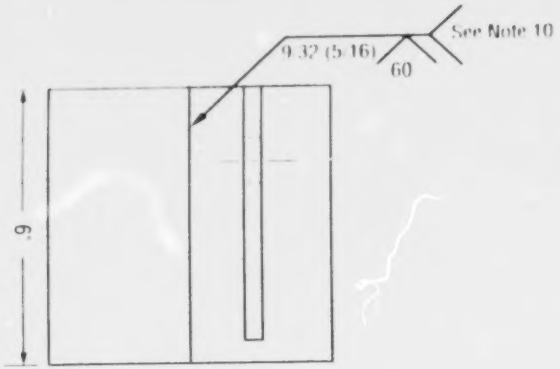
American Welding Society

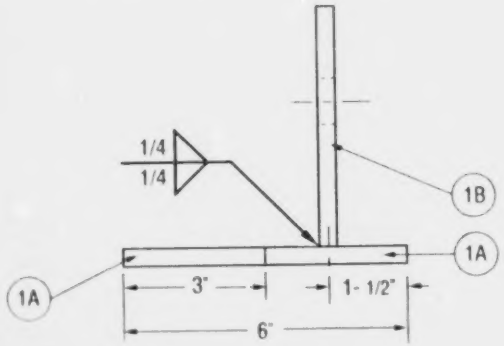
TOLERANCES (Unless Otherwise Specified) DO NOT SCALE DRAWING Fractions ± 1/16 Angles ±10 .5	Entry Level Welder — GMAW-S, FCAW-G, FCAW — Workmanship Qualification			
DR BY S. Ambelang DATE 1-5-95	SIZE	QC NO 10-95	DWG NO AWS-1	REV
CHK BY K. V. Rees DATE 1-6-95	APPROVED AWS EGC	DATE 1/31/95	SHEET 1 of 1	

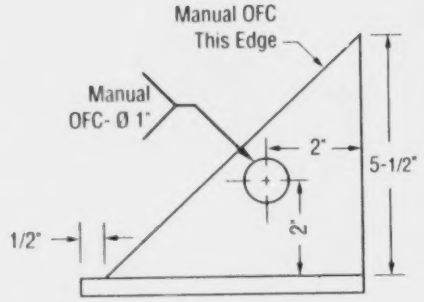
Figure 3 -GMAW (Spray Transfer) Workmanship Qualification Test.

INCH	MM
1/16	1.6
1/8	3.2
1/4	6.4
1/2	12.7
1	25.4

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED







NOTES
1. All dimensions U.S. customary unless otherwise specified.
2. 3/8" thickness plain carbon steel material
3. The welder shall prepare a bill of materials in U.S. customary units of measure prior to cutting.
4. The welder shall convert the above bill of materials to S.I. metric units of measure.
5. All parts may be mechanically cut or machine OFC unless specified manual OFC.
6. All welds GMAW, spray transfer.
7. Fit and tack entire assembly on bench before welding.
8. ALL WELDING DONE IN POSITION ACCORDING TO DRAWING ORIENTATION.
9. Employ boxing technique where applicable.
10. Melt through not required.
11. Use WPS AWS-2-GMAW.
12. Visual examination in accordance with the requirements of AWS QC10, Table 1.

PART	No. REQD	SIZE	S.I. CONVERSION
1A			
1B			

American Welding Society

TOLERANCES (Unless Otherwise Specified) DO NOT SCALE DRAWING Fractions ± 1/16" Angles + 10', -5'		Entry Level Welder — GMAW (Spray Transfer)— Workmanship Qualification			
DR BY: S. Canlelope	DATE: 1/11/95	SIZE	QC NO: 10-95	DWG NO: AWS-2	REV:
CHK BY: R.J. Reese	DATE: 1/12/95	APPROVED: AWS-EGC	DATE: 1/31/95	SHEET: 1 of 1	

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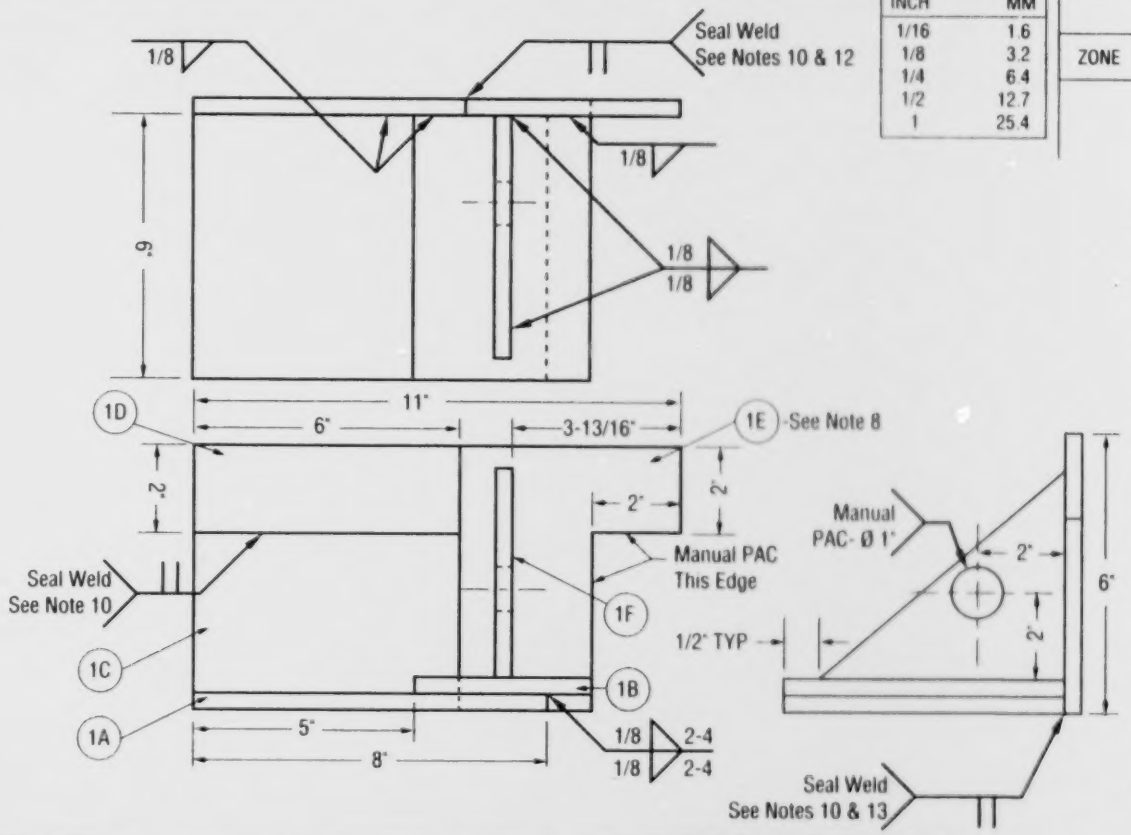
Figure 4 - GTAW - Plain Carbon Steel - Workmanship Qualification Test.



INCH	MM
1/16	1.6
1/8	3.2
1/4	6.4
1/2	12.7
1	25.4

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

NOTES

1. All dimensions U.S. customary unless otherwise specified.
2. 10 ga. - 18 ga. thickness plain carbon steel material. Optional choice of thickness within range specified.
3. The welder shall prepare a bill of materials in U.S. customary units of measure prior to cutting.
4. The welder shall convert the above bill of materials to S.I. metric units of measure.
5. All parts may be mechanically cut or machine PAC unless specified manual PAC.
6. All welds GTAW.
7. Fit and tack entire assembly on bench before attaching to positioning fixture arm.
8. Attach 2" x 2" extension tab of part 1E to positioning fixture arm. ALL WELDING DONE IN POSITION ACCORDING TO DRAWING ORIENTATION.
9. Employ boxing technique where applicable.
10. Melt through not required.
11. Use WPS B2.1-008.
12. Weld joins Parts 1C and 1D to 1E.
13. Weld joins Parts 1C and 1E to 1A.
14. Visual examination in accordance with the requirements of AWS QC10, Table 1.

PART	No. REQD	SIZE	S.I. CONVERSION
1A			
1B			
1C			
1D			
1E			
1F			

American Welding Society

TOLERANCES (Unless Otherwise Specified)
DO NOT SCALE DRAWING
Fractions ± 1/16" Angles ± 10' .5

Entry Level Welder — GTAW, Carbon Steel — Workmanship Qualification

DR BY: T. Cantelpe DATE: 1 11 95
CHK BY: R. Pace DATE: 1 12 95
SIZE | QC NO: 10-95 | DWG NO: AWS-3 | REV
APPROVED: AWS EGC 1/31/95 DATE | SHEET: 1 of 1

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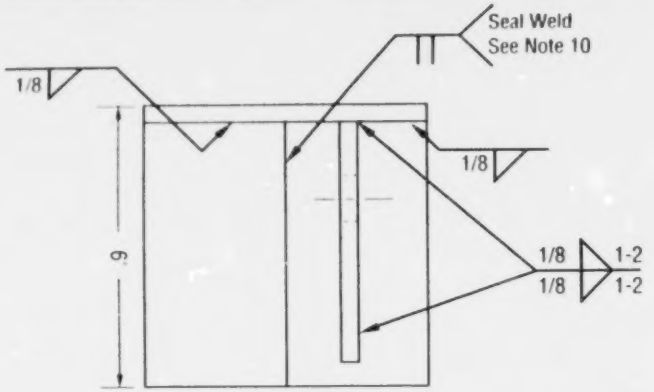
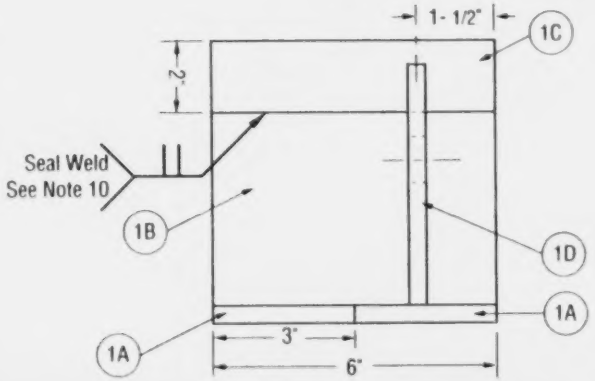
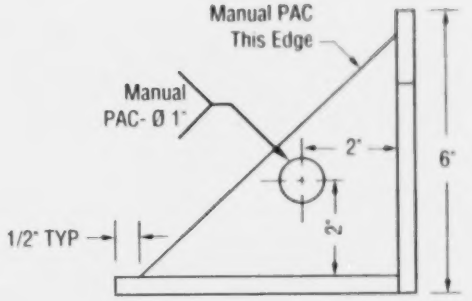
Figure 5 -GTAW - Stainless Steel - Workmanship Qualification Test.







INCH	MM
1/16	1.6
1/8	3.2
1/4	6.4
1/2	12.7
1	25.4

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

NOTES

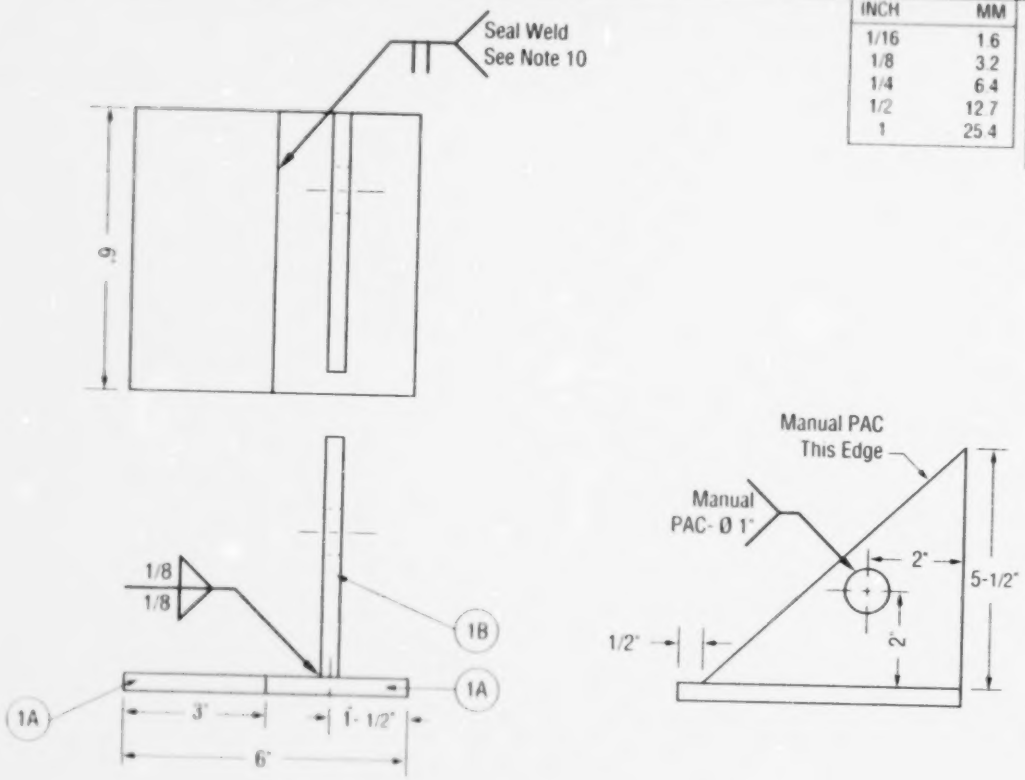
1. All dimensions U.S. customary unless otherwise specified.
2. 10 ga. - 18 ga. thickness stainless steel material. Optional choice of thickness within range specified.
3. The welder shall prepare a bill of materials in U.S. customary units of measure prior to cutting.
4. The welder shall convert the above bill of materials to S.I. metric units of measure.
5. All parts may be mechanically cut or machine PAC unless specified manual PAC.
6. All welds GTAW.
7. Fit and tack entire assembly on bench before welding.
8. ALL WELDING DONE IN POSITION ACCORDING TO DRAWING ORIENTATION.
9. Employ boxing technique where applicable.
10. Melt through not required.
11. Use WPS B2.1.009.
12. Visual examination in accordance with the requirements of AWS QC10, Table 1.

PART	No. REQD	SIZE	S.I. CONVERSION
1A			
1B			
1C			
1D			

American Welding Society

TOLERANCES (Unless Otherwise Specified) DO NOT SCALE DRAWING Fractions ± 1/16" Angles ± 10', -5'	Entry Level Welder — GTAW, Stainless Steel — Workmanship Qualification			
DR BY: L. Cantelope DATE: 1/11/95	SIZE	QC NO: 10-95	DWG NO: AWS-4	REV:
CHK BY: R.J. Reeve DATE: 1/12/95	APPROVED: AWS-EGC DATE: 1/31/95		SHEET: 1 of 1	

Figure 6 - GTAW - Aluminum - Workmanship Qualification Test.



INCH	MM
1/16	1.6
1/8	3.2
1/4	6.4
1/2	12.7
1	25.4

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

NOTES

1. All dimensions U.S. customary unless otherwise specified.
2. 10 ga. - 18 ga. thickness aluminum material. Optional choice of thickness within range specified.
3. The welder shall prepare a bill of materials in U.S. customary units of measure prior to cutting.
4. The welder shall convert the above bill of materials to S.I. metric units of measure.
5. All parts may be mechanically cut or machine PAC unless specified manual PAC.
6. All welds GMAW, spray transfer.
7. Fit and tack entire assembly on bench before welding.
8. ALL WELDING DONE IN POSITION ACCORDING TO DRAWING ORIENTATION.
9. Employ boxing technique where applicable.
10. Melt through not required.
11. Use WPS B2.1.015 for aluminum (M-22 or P-22).
11. Use WPS AWS-5-GTAW for aluminum (M-23).
12. Visual examination in accordance with the requirements of AWS QC10, Table 1.

PART	No. REQD	SIZE	S.I. CONVERSION
1A			
1B			

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American Welding Society

TOLERANCES (Unless Otherwise Specified) DO NOT SCALE DRAWING Fractions ± 1/16" Angles ± 10 .5"	Entry Level Welder — GTAW — Aluminum — Workmanship Qualification			
DR BY: A. Cantelpe DATE: 1 11 95	SIZE	QC NO: 10-95	DWG NO: AWS-5	REV:
CHK BY: R.L. Reeve DATE: 1 12 95	APPROVED: AWS-EGC 1/31/95 DATE:		SHEET: 1 of 1	

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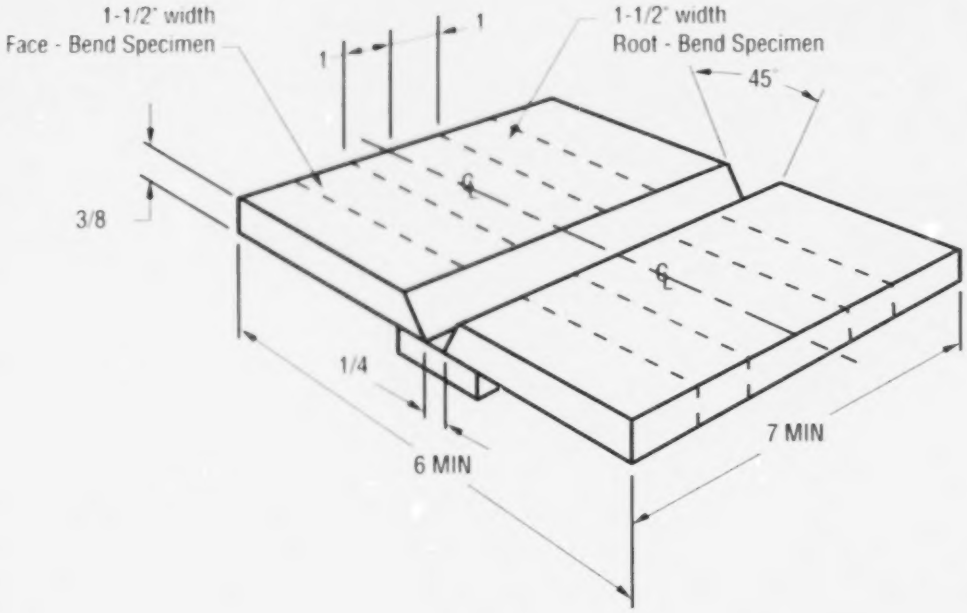
Figure 7 - SMAW Performance Qualification Test.

1.16	1.6
1.8	3.2
1.4	6.4
1.2	12.7
1 -	25.4

REVISIONS

ZONE	REV	DESCRIPTION	DATE	APPROVED



Notes:

1. 3/8" thickness plain carbon steel material.
2. Performance Qualification #1 = 2G position.
   Performance Qualification #2 = 3G position.
3. All welding done in position according to applicable performance qualification requirement.
4. The backing thickness shall be 1/4 in. min to 3/8 in. max; backing width 1 in. min.
5. All parts may be mechanically cut or machine OFC.
6. Use WPS B2.1.001
7. Visual examination in accordance with the requirements of QC10, Table 1.
   Bend test in accordance with the requirements of QC10, Table 2.

American Welding Society

TOLERANCES (Unless Otherwise Specified) DO NOT SCALE DRAWING Fractions ± 1/16" Angles + 10', -5'		Entry Level Welder — SMAW — Carbon Steel 2G & 3G — Performance Qualification			
DR BY: D. Canteluppe	DATE: 1 11 95	SIZE:	QC NO: 10-95	DWG NO: AWS-6	REV:
CHK BY: R.J. Reeve	DATE: 1 12 95	APPROVED: AWS-EGC	DATE: 1/31/95	SHEET: 1 of 1	

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ANNEX A
Recommendations for Support Personnel and Systems

A1.0 Program Administrator

The administrator, director, or supervisor of any welding program should be familiar with all types of welding. A practical background in the welding industry would be very helpful. In addition to meeting the minimum state certification requirements, the program administrator should be experienced in both instruction and program execution.

Because of the importance of continued contact with area industry, the administrator should be encouraged to join and maintain a membership in the American Welding Society and be active in the local AWS Section. Membership in other professional organizations, particularly in the materials (metals) or educational field, would also be very helpful. Such participation will allow a welding program administrator to maintain effective working relationships with members of local industry, technical experts, and fellow educators. Moreover, the administrator's commitment to these activities sets the example for not only the instructors but also the welding personnel.

A2.0 Business and Industry Services Liaison (BISL)

A full time liaison with no other responsibilities, representing the schools' vocational trades interests should be established. This individual should be a certified staff member with previous experience as a cooperative vocational education coordinator or a guidance counselor with job placement background. This individual should also have a strong understanding of both education and work environments. The responsibilities of the position should include:

- Formation of a Business & Industry Services Unit
- Identification of prospective trainees
- Assisting students to successfully fulfill all the proposed school requirements
- Administration and maintenance of records, coordination of student placement
- Conducting follow-up trainee surveys
- Teaching of the employability skills curriculum
- Maintaining close cooperation with the Advisory Council or Private Industry Council

The "*BISL*" is the direct contact with the Advisory or Private Sector Coordinator.

A2.1 Business and Industry Services Unit (BISU)

A team of professionals from the BISU coordinates the trades initiative. Under the direction of the Business Industry Services Liaison (BISL), the unit serves as the in-school component, for implementing a series of coordinated activities on a daily basis, designed to assist trainees, to acquire prerequisite skills and experiences needed to secure and retain full time employment upon graduation of their respective programs. The unit coordinates its activities with the Advisory Council. The BISU should consist of:

- Business Industry Services Liaison
- Site Principal or President
- Basic Skills Coordinators
- Bilingual and/or ESL Coordinators
- Guidance Staff
- Vocational Education Coordinator

The *"BISU"* has the responsibility to coordinate and conduct activities for:

- Assessment and interpretation of a trainee's interests and abilities with employment services
- Providing career seminars for trainees
- Maintaining a career resource center
- Delivering a computerized guidance information system
- Activating parent groups
- Implementing shadowing, internship, and apprentice experiences for students
- Developing part-time/summer job placement and full time job placement
- Conducting program evaluations
- Developing trainee career profiles
- Development of a yearly action plan
- Meeting monthly to discuss each trainee
- Developing individualized instruction to assist each participant to complete program requirem
- Developing activities in coordination with members of the Advisory Council to implen program objectives
- Plan meetings with the Advisory Committee on a periodic (quarterly) basis

A3.0 Advisory Council

The Council comprises a group of selected individuals based on their knowledge and expertis advise those involved in the training initiative on: current labor needs, development of relev courses/programs, and the competencies offered in each of the courses or programs. This unit in housed within the confines of each training system, but its members are called upon frequently to as in the development of individualized student programs. The Advisory Council consists of:

- Private Sector Coordinator (representing either JTPA or PIC)
- Job Placement Coordinator
- District Curriculum Coordinator (for grades 7-12)
- Employment Service Representative
- Parent (PTA/PTO) Representative (secondary institutions)
- Business and Industry Representative
- Organized Labor Representative
- Military Representative (for areas of civilian employment served by the Armed Forces)

A4.0 Private Sector Coordinator

The Private Sector Coordinator is a full time employee of the State Department of Labor (JTPA/PIC located within each program service delivery area. Private Sector Coordinators work closely wit business and industry to develop part time/summer and full time jobs, as well as compile and updat jobs. These jobs are then provided to the employment service for use in a computerized job bank t match identified eligible trainees to summer and full time jobs. The Private Sector Coordinator' function is to:

- Develop cooperative agreements with the training facilities of their designated areas (terms fo state program funding)
- Offer liaison with all schools or training facilities within their jurisdiction

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- Be responsible for bringing together representatives of business and industry
- Report to the Private Industry Council (PIC) director/chairman of their designated area in carrying out the terms of the cooperative agreement (JTPA) or similar state and federally administered models
- Coordinate PIC and LEA (school board) groups to assist eligible youth with the opportunity to participate in other services provided by the Private Industry Council (tuition refunds, travel allowances, food, clothing, tools, etc.)

A5.0 Advisory Committee

The Committee is a conglomerate of all interested training incentive sectors. It assists in the advertisement of program implementation, formulation of trainee learning contracts, informing training facility personnel and the community about the program, providing orientation for potential training candidates, their spouses and or parents, planning and implementing "launching" activities, review of final reports and evaluations, and the review of follow-up surveys. The Committee is comprised of:

- Business Industry Services Liaison (chairperson)
- Local section representative of the American Welding Society (AWS),
- Assistant Superintendent of Schools or Assistant President of the College Board of Regents
- Human Resource Development Director or Director of Guidance
- Cooperative Education Coordinators
- Parent Representative (secondary systems)
- Trainee Representative (Level III, should have an active voice in training)
- Members from a school district offering a comprehensive welding curriculum
- Community Agency Representatives
- Business and Industry Representatives
  - Welding Engineer
  - Welding Inspector
  - Welding Technician
  - Welding Supervisor
  - One or two experienced welders
  - Welding supply representatives
- Private Industry Council Representative
- State Employment Representative

The duties of the Advisory Committee may vary according to the preferences and composition of the representatives from the geographical area and various state models. However, the baseline duties should include the following:

- Providing advice and assistance in the selection, purchase, and installation of equipment appropriate to both the instructional environment and the requirements of modern industry.
- Assisting in the development and implementation of continuing education experiences, including advanced course work, for welding educators.
- Assisting with the preparation and review of instructional materials and the ongoing development of instructional pedagogy.

- Fostering participation in appropriate community service and educational projects, stressing the value of such activities as an excellent means of recruiting and motivating individuals.
- Encouraging welding personnel to apply for scholarships and enter competitions sponsored by such entities as the American Welding Society (AWS), Vocational Industrial Club of America (V.I.C.A.), and other educational opportunities.
- Helping with follow-up surveys of graduates who have been successfully placed in welding-related occupations.
- Supporting the program through assistance in public relations and welding personnel recruitment
- Sponsoring career days, plant tours, and related activities designed to stimulate interest in welding and related fields as possible career opportunities.
- Provide assistance in obtaining welding practice materials.
- Provide internship opportunities in area businesses.

A6.0 AWS Certified Welding Educator (AWS QC5)

The Welding Instructor is a person who recognizes welding training requirements, prepares instructional plans, conducts training classes and evaluates welding personnel performance. This instructor may teach using prepared instructional materials or prepare original instructional materials. Most states require instructor certification which includes meeting selective academic standards and demonstrating experience from that related industry.

The instructor should be certified by AWS QC5, *Standard for Certification of Welding Educators*. The instructor should also be certified by AWS QC7, *Standard for AWS Certified Welders* in the processes, positions, base metals, and filler materials involved with the courses being taught.

Instructors should be responsible for continually updating their technical knowledge. Furthermore, it is incumbent upon welding instructors to strive to enhance their own teaching abilities. Welding instructors will find participation in the programs of appropriate industry and educational associations beneficial to their effectiveness as educators. On a regular basis, instructors, as members of AWS, should visit local industry, attend area welding educational programs sponsored by local AWS sections and/or the annual AWS International Welding Exposition in order to stay up-to-date on the latest technological trends. Industry and trade magazines provide another excellent means of continuing education and many are available to educators free of cost. Attitude, demeanor, and dedication to the welding industry are essential qualities as instructors set the example for their welding students.

A7.0 AWS Certified Welder Program (AWS QC7)

The primary program for Entry Level Welder Training is AWS QC10, Specification for Qualification and Certification for Entry Level Welders. The AWS Certified Welder program is for advanced trainees and experienced welders seeking certification to a particular welding code as AWS Certified Welders.

The American Welding Society (AWS) Certified Welder Program was established to identify all elements necessary to implement a National Registry of Certified Welders. The four key elements of this standard (AWS QC7, *Standard for AWS Certified Welders*) include:

- Welder performance qualification standards
- Standard welding procedure specifications
- Accredited performance qualification test facilities
- AWS welder certification requirements

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The QC7 standard contains the criteria for the AWS Certified Welder Program and the AWS National Registry of Welders. The purpose of this standard is:

- To determine the ability of welders to deposit sound welds in accordance with standardized requirements.
- To impose sufficient controls on the documentation and maintenance of certification to allow transfer between employers without requalification, where allowed by standard or contract documents.

Applicants, upon successful completion of qualification testing, become certified, and are issued an identification/qualification limits card encased in plastic. This identification/qualification limits card shall be used to identify certified welders and their limits of certification. The AWS certification of a welder is effective for a period of one year from the date of certification. Prior to the end of the certification period, an application for recertification may be made if:

- The welder retests
- The welder submits form QC-WF3 attesting to having welded satisfactorily in each six month period of the one year with the process(es) qualified for.

A8.0 AWS Accredited Test Facilities (AWS QC4)

AWS Accredited Test Facilities are designed to implement the QC7 program. Under this program instructors may not test and qualify welders they have trained. In the QC10 program for entry level welders, instructors are afforded the latitude of training, testing and qualifying trainees.

AWS QC4, *Standard for Accreditation of Test Facilities for AWS Certified Welder Program*, establishes minimum requirements for Test Facilities, their personnel, and equipment to qualify for accreditation to test and qualify welders in the AWS Certified Welder Program. This facility accreditation program is open to all Test Facilities that are qualified, whether or not they are members of AWS. The Test Facilities may be part of an independent laboratory, manufacturing plan, educational institution, or other party.

The purpose of a third-party accreditation of Test Facilities for welder qualification is to confirm that a Test Facility has the personnel, organization, experience, procedures, knowledge, equipment, capability, and commitment to conduct proper welder qualification testing for the AWS Certified Welder Program. AWS QC4 describes the requirements and functions of the Test Facility to achieve this purpose and to complete reliable reports and to define the relationships between the Test Facility and the other parties involved.

The AWS Accredited Test Facilities conduct welder qualification tests for the AWS Certified Welder Program. A person wishing to take tests to become an AWS certified welder prepares an application in accordance with AWS QC7. The applicant is responsible for contacting the Test Facility to arrange a specific date and time for the completion of the qualification test assembly. All acceptable test results and records will be forwarded to AWS by the Test Facility after the welder qualification test is completed.

A9.0 Safety Requirements

All schools shall develop and enforce sound safety programs, beginning with the orientation of welding personnel and continuing through graduation. Each school shall teach safety theory and

practice safety at all times. All safety practices shall conform to local, state, and federal regulations, and ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes*; ANSI/AWS F2.2, *Lens Shade Selector*; ANSI/AWS F3.1, *Guide for Welding Fume Control*; ANSI/AWS F4.1, *Recommended Safe Practices for the Preparation for Welding and Cutting of Containers That Have Held Hazardous Substances* and general work place safety.

A10.0 Evaluations

The purpose of the evaluation program is to directly and efficiently respond to the identified needs of:

- Diverse trainee populations
- Corporate training institutions
- The communities and industries served

Responding to these needs improves each trainee's opportunity for access to training and increasing the numbers of students completing training objectives related to the service needs of the employing community.

The process should include administering diagnostic assessment instruments to determine the prospective training clients' current knowledge, attitude, skills, and habits (KASH) as contrasted to the clients initial career interest. In addition, this evaluation should define and implement duties, role relationships and tasks of the instructional and supportive advisement staff to deliver appropriate services generated from the diagnostic assessment system.

As each step of training is completed, the results of both written and performance tests should be communicated to each individual and duly recorded in an appropriate format. The number of hours of welding theory and practice completed, by process, should also be recorded. The purpose of this information is to develop a career profile for each trainee.

The program evaluations should be three-phase:

Formative: To measure learning progress at each step of the program and provide diagnostic prescriptions for learning problems that require remedial work.

Summative: To determine if the learner has mastered the learning tasks to such a degree that he/she may move to the next course, unit or level of instruction, and to determine some type of grade assignment.

Follow-up: To measure the trainee's effectiveness on the job and the training facility's delivery of the instructional programs. Follow up evaluation is meant to determine whether the school or facility has met the needs of industry. Follow-up surveys are used by the Advisory Council and Advisory Committee to track program performance and to make prescriptive recommendations for weak training areas.

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ANNEX B
Recommendations for the Trainee Population

B1.0 Entrance Requirements

B1.1 Career Guidance. The success of recruiting prospective individuals into the welding field will depend on the pre-placement assessment, testing and guidance provided to that individual. The Business Industry Services Unit personnel should emphasize the very real opportunities inherent in choosing welding as a career path. Current and long-term needs for skilled welders demand that career counselors present welding as a positive career. Business Industry Services Unit personnel and the Advisory Committee members play an important role in ensuring that career counselors and the administrative committee have regular, positive contact with the welding industry through plant tours, open houses, and personal contacts. Guidance counselors must be made aware that welding not only provides an excellent entry level career, but can also provide preparation for positions such as welding supervisor, quality assurance inspector, production scheduler, etc. Moreover, career enhancement should not cease once training is completed. The Instructors and the Advisory Committee should work with the Business Industry Services Unit to place graduates in appropriate positions and to track their subsequent successes.

B1.2 Basic Prerequisites. Standards for admittance to the welding program should be established by formal evaluation of prospective welding personnel. A basic foundation in computation, physical science, learning to learn, reading, writing, problem solving abilities, creative thinking, interpersonal skills and teamwork is necessary if a person is to have a successful career in welding. In the event that some prospective welding personnel do not demonstrate the academic skills necessary to understand the subject matter, a "remedial" program, at the same location or nearby training facility, should be set up to provide the missing academic foundation necessary for welding training.

B1.3 Aptitude. Each training program should incorporate some form of pre-placement test(s) to help screen and orient prospective welding personnel. There should be some form of diagnostic assessment and academic advisement. Whether or not they are used specifically for screening, a welding aptitude test can provide valuable insight into an individual's unique educational abilities and needs. As an example, welding simulators are one aid available to assist in this determination. Both written exercises and tests for manual dexterity, should be considered when evaluating the prospective individual's overall aptitude.

B1.4 Health. Safe operation of the welding equipment and maintaining a work environment appropriate to the welding industry are paramount. Prospective welder trainees should have the ability to meet these critical requirements.

B1.5 Age. Individuals must meet the minimum age requirements stipulated by applicable state and federal laws.

B1.6 Probationary Period. All trainees should be given a trial period in which to demonstrate their ability to perform, and develop good work habits as required by industry. The time limit for such a period will vary according to the institution and type of instruction, but should not exceed 15 percent of the course length. A public school situation may permit a longer time, versus that allowed by a private

or industrial training program. During this probationary period, the educator must determine whether, in the interests of all concerned, the individual should continue the course of instruction.

B2.0 Trainee/Instructor Ratio.

The trainee-instructor ratio for each course should be kept as low as possible. A reasonable figure would be fifteen (15) welding personnel to one (1) welding instructor. However, this ratio should **never** exceed the number of work stations in the laboratory. Twenty (20) welding personnel to one (1) instructor would be the **maximum** acceptable ratio.

B3.0 Trainee/Machine Ratio.

Only one (1) individual should be assigned to a power source at a time. Placing more than one (1) individual in a booth or work station is unacceptable for positive training, disciplinary purposes, and safety.

ANNEX C
Recommendations for Facility Planning

C1.0 School Facilities

C1.1 Primary Structure(s). The building should be fireproof and well designed. Welding instructional facilities will function best if located on the ground floor, preferably in a one story wing of the main building or in a separate building with covered access ways. Instructional areas in which noisy activities are conducted are best placed farthest from other academic areas of the school or production areas in an industrial facility. Walls should be smooth, with no ledges to collect dust. Floors must be fire resistant, waterproof, and contain adequate floor drains. A minimum light level of 100 foot-candles (100 candela) 30 inches (762 millimeters) from the floor is recommended. To enhance motivation and morale, adequate natural light from windows and skylights should be available. Walls should be prepared with a low reflective paint to reduce ultraviolet radiation. "Cool" colors, blues or greens, are recommended. The various work stations in a laboratory should meet the following objectives:

- Provide suitable facilities where the instructor may demonstrate the skills and techniques necessary to develop welding competencies.
- Provide a place at which the welding students may develop such competencies.
- Provide an area in which power sources, equipment and projects may be secured and serviced.
- For specific industry welding training facilities, provide special fixturing and production work mock-ups to adequately demonstrate the production work to be expected in order to all students to experience typical job related welding positions, conditions, and interferences.

A modular system of layout should be considered so that a two fold criteria for modern building planning (i.e., flexibility and expandability) can be achieved. The former is accomplished by allowing the maximum possible interchange of work stations and other facilities. Future expansion is planned in terms of multiples of specific work stations needed rather than in terms of the general area to be added. These features would simplify the work of the architect, increase the usable life of the laboratory, and provide the instructor with more possibilities to offer curriculum changes.

The flexibility and expandability of laboratories should be greatly enhanced if architectural design permits use of nonload-bearing partitions between adjoining areas. Good planning includes the provision of doors large enough to permit easy entry of the largest piece of equipment into each shop. In addition, placement of such doors to permit the maximum degree of future flexibility with changes in partition locations should be considered.

If facilities are to be used for evening classes, easily accessible outside entrances which eliminate the necessity of opening or lighting other parts of the building offer important savings in operating and maintenance costs.

C1.2 Classroom(s). Ideally, a room for instruction should be about 20 feet (6.1 meters) X 24 feet (7.3 meters) and adjacent to the laboratory. Classrooms should provide a clear (but protective) view of the laboratory area. The minimum ceiling height should be 12 feet (3.7 meters) or higher. Classrooms must be acoustically insulated from laboratory noise. This space should have chalk and tack boards, a demonstration table, adequate seating facilities and provision for darkening for the use of visual aids. At least one bulletin board should be near the main entrance. Instructors and welding personnel must

have nominal access to the classroom. Storage for audiovisual equipment, charts, models, samples, reference texts, etc., need to be provided. Exhibit cases have strong appeal to parents and observers, especially when located to permit viewing from the outside corridor.

C1.3 Laboratory. A minimum of 100 square feet (9.3 square meters) of laboratory floor space per individual is considered a good general planning figure, exclusive of washroom, storage, office space and the classroom. At the outset the architect and laboratory planner must take into account state recommendations as to minimum square footage per individual. While they vary from state to state, factors of 75 square feet (7.0 square meters) to 150 square feet (13.9 square meters) of work space per individual and a minimum of 400 square feet (37.2 square meters) to 800 square feet (74.3 square meters) for material storage are generally accepted requirements for this particular size area and the subjects to be taught. Floor dimensions of 40 feet (12.2 meters) x 85 feet (25.9 meters) are reasonably close to the normally accepted length to width proportions of 2 to 1. The minimum ceiling (clearance) height should be no less than 14 feet (4.3 meters). At least one entrance must be large enough [14 feet (4.3 meters) x 14 feet (4.3 meters)] to accommodate bulky materials, equipment and projects. Future expansion should always be considered. While projections of this nature are sometimes only educated guesses at best, adaptability for reorganization should be kept in mind. This should permit additional enrollment, new equipment, or extra shop subjects to be reasonably accommodated without going below space-per-individual minimums.

Where a hazard exists around machines, the power equipment should be so placed that welding personnel are not in the line of danger. Added protection is given by enclosing this equipment in a safety zone painted on the floor. Wide aisles of travel should be provided between benches, machines, and in areas in front of tool cabinets and storage lockers. These aisles should be a minimum of 3 feet (.9 meters) in width. Aisles of travel may be designated by painted lines similar to those used in industry. Non-skid surfaces such as sand on shellac should be applied to the floor in the area around machines to minimize danger of slipping.

A 6 feet (1.8 meters) X 6 feet (1.8 meters) area should be planned for process booths and ought not to contain a power source. Welding booths must be constructed of fire resistant material, with the walls open at least 12 inches (305 millimeters) at the bottom to permit air circulation. All four sides of the welding booth should provide complete protection to the welding personnel and others in the area from harmful rays and hot sparks. A minimum of one 10 feet (3.1 meters) x 10 feet (3.1 meters) demonstration area should be available for every 20 welding personnel. Positioning jigs, independent of other activities to prevent congestion, should be provided.

Tools and supplies should be located as near to work areas as practical to reduce travel and interferences. Machines should be placed to allow for ease of cleaning around the base. Cabinets should fit flush to walls or be trimmed to fit flush for the same reason. Bases for cabinets and benches should provide toe space for comfort and safety of workers.

C1.4 Office(s). The entrance to the instructor's office should be easily accessible from the classroom, laboratory and facility corridor. Activities in the classroom and laboratory must be visible from the office. The office window space should be designed to provide maximum vision to all areas along with proper ultra violet light protection. The office ought to provide at least 120 square feet (11.2 square meters) of floor space per instructor [size 10 feet (3.1 meters) x 12 feet (3.7 meters)]. The office needs to be planned with at least one 3 foot (.9 meters) wide door, tile or carpet flooring cover, and an acoustical ceiling with fluorescent lighting. For instructional use and laboratory safety the office should

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have a telephone. It should also have room for file cabinets, desk, bench with storage underneath for weld supplies, a shelf for boots, and room for two chairs for counseling welding personnel.

C1.5 Storage. Decentralized storage should help conserve space and increase efficiency by reducing individual traffic. A storage area for bar stock should be at least 20 feet long (6.1 meters) and 7 feet wide (2.1 meters), with a door centered at both ends. This permits both economical purchase of steel in long lengths and wall storage within the room. Use of horizontal or vertical racks depends on space limitations and personal preference. Storage of bulk supplies (adequately secured) should be located adjacent to an outside service door for convenient delivery.

Adequate filler metal storage should be considered and should be controlled. Rod, wire, and fluxes, depending on their nature, must be maintained under certain storage conditions. The materials of higher value or requiring temperature control should require the tighter controls to ensure that product quality is retained. Acquisition of a specially designed electrode storage oven is highly recommended.

Open tool cabinets in each process area should conserve welding personnel time and travel while helping them associate proper tool selection and application with a particular activity. This also provides for easy checking of tools. Space underneath benches and tables is excellent for storage of hardware, small amounts of raw stock or even small projects. Storage for projects of welding personnel and personal belongings is always a problem and should be well thought out.

Cylinder storage should be located near the laboratory, but accessible to truck traffic. All volatile material(s) should be stored outside in an identified, isolated area to minimize the potential hazards involved. Cylinder storage **shall** follow the guidelines set forth in ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes*, Part II Specific Processes, 10.8.2 Cylinder Storage.

One door should open directly to the outside from this room so that stock may be loaded into the room with no interference to shop activities. Scrap storage could be located near this entrance. Thus, material storage areas or rooms should be located conveniently for issuing materials to the welding personnel, for cutting large stock to project size and for the unloading of delivery trucks.

C1.6 Personal Services. Personal Services should be planned into the laboratory, both for convenience and efficiency. Individual lockers for books and clothing should be near the entrance to keep these items out of the main instructional area. A wash-up sink and water fountain and, where possible, a lavatory (for both genders) should also be included near the entrance.

C1.7 Budget. Adequate financial resources should be considered and support provided to not only maintain the program, but also enhance it. Funding for power sources, filler metals, gases, and fluxes along with power equipment and hand tools are just the basics. Additional monies should be available to provide the materials necessary for adequate welding instruction. As necessary, staff and faculty should also have included in the budget resources (i.e., release time and dollars) to provide for their technical as well as professional development.

C1.8 Lighting. 100 foot-candles (100 candela) should be the absolute minimum recommended for general work in any shop while 140 foot candles (140 candela) would be recommended for more difficult or inspection work. In most cases, the use of indirect lighting to avoid glare and evenly diffuse the light is recommended. When needed, individual machines can be lighted by lamp attachments or through their own built-in lighting systems. Providing uniform distribution of shadow-free light through the use of indirect or semi-indirect deflectors should also be considered. Adequate lighting shall also be found in each booth.

C1.9 Electricity. Electrical power should be supplied with adequate voltage and amperage for each power source. Electrical service should be 208 volt, 230/240 volt or 460/480 volt, single-phase or three-phase, and 60/50 cycle (60/50 Hertz), alternating current. The primary service should never be less than 208 volts. Current capacity of 75 percent more than the known demand should be provided for expansion in the welding facility. Electrical outlets for 110/120 volt service should be placed at convenient locations every 12 feet (3.7 meters) and in every booth. Ground fault interrupters should be provided throughout the shop. The use of magnetic starters on all equipment is an additional safety feature which gives a machine motor overload protection as well as low-voltage, and no-voltage protection. After a power failure has been corrected, the machine will not start (even if it was running when the failure occurred) until the operator presses the start button.

A disconnect switch that can be locked out, must be provided to cut off all power equipment, including power sources, in the shop. Panic switches should be strategically located around the entire shop or laboratory and their locations known by all welding personnel. They should be wired to cut off power to every machine. Fused disconnect switches should be provided for each power source and there should be no exposed wiring.

C1.10 Ventilation. Individual, movable exhaust hoods are highly desirable at the work site. Welding station exhaust should be separate from other laboratory exhaust systems. The minimum required air velocity at the zone of welding is 100 feet per minute (.5 meters per second) when the hood is at its farthest position from the joint being welded. The hood size and height could be reduced to lower the required capacity of the exhaust system. The use of a qualified heating, ventilation, and air conditioning (HVAC) contractor is strongly recommended, rather than having a inexperienced sheet metal firm perform the construction. Fire resistant, safety yellow, strip curtains could be lowered to form a booth when greater exhaust efficiency is desired at the demonstration area

For the single welding booth, it is practical to design a hood exhaust system. When there are a large number of booths being used, it is more practical to provide exhaust at the arc than for the entire room. However, the loss of heat during the cold months is a serious objection to the room ventilation method unless a heated air intake system is used. To avoid this heat loss, electronic precipitators, which clean the exhausted air and reintroduce it back into the laboratory to save heat and air conditioned air, should be used. These units need careful placement as welding schools create more smoke than most industry applications due to large numbers of units in a contained work area.

C1.11 Heating. Heating and cooling capacity must take into consideration the provision for a supply of fresh, clean incoming air. The laboratory heating system should automatically maintain a temperature of 68° Fahrenheit (20° Celsius) measured 60 inches (1.5 meters) above the floor. The classroom and the office should be kept at 70° Fahrenheit (21° Celsius) measured 30 inches (762 millimeters) above the floor. A system of even heat distribution should be kept within 5% of these temperatures for health reasons and for stability of equipment and stored materials.

C1.12 Water. Hot and cold running water, with suitable drinking fountains in the laboratory, and convenient sanitary restrooms are necessities. Washing facilities of either the half round or trough type sink are essential and, as a rule of thumb, should be adequate to accommodate one quarter of the welding personnel simultaneously. Location of the washing facilities should be as near the door as feasible. Drinking fountains are highly desirable and should be available within the welding facility. A safety shower and eye wash station should also be located within each laboratory area. Proper drainage must be considered during installation.

C1.13 Safety. Information regarding safety can be found in ANSI Z49.1 *Safety in Welding, Cutting and Allied Processes*; ANSI/AWS F2.2, *Lens Shade Selector*; ANSI/AWS F3.1, *Guide for Welding Fume Control*; AWS F4.1, *Recommended Safe Practices for the Preparation for Welding and Cutting of Containers That Have Held Hazardous Substances*, as well as all other applicable local, state and federal regulations. Equipment must conform to the OSHA requirements for "lockout and tagout."

All safety features of the primary structure(s) and its support system(s) must conform to any local, state or federal governing codes. The school must be able to pass an inspection of the local and state Fire Marshal and possess a certificate of conformance from the regional OSHA engineer.

C2.0 Equipment and Supplies

C2.1 Instructional Equipment

C2.2 Welding/Cutting. The total number of welding work stations should exceed the number of welding personnel enrolled. Ideally, there should be 25 percent more welding stations than there are welding personnel, in order to provide for expansion of enrollment. Most of the stations should be equipped with multi-process power sources. Since SMAW is the most popular welding process, it and at least one other joining process should be linked together.

C2.2.1 Arc Welding. At least thirteen (13) combination constant current/constant voltage power sources for SMAW, GMAW, GTAW, and FCAW, and thirteen (13) constant current AC/DC power sources with high frequency for GTAW should be provided for every 20 welding personnel. Local industry and adult extension classes may dictate modifications to this structure.

Power sources for SMAW, and GTAW should have a minimum rated output of 60% duty cycle at 300 amperes. Power sources for GMAW and FCAW should have a minimum rated output of 100% duty cycle at 300 amperes. Power sources must be installed in accordance with the National Electrical Code, and be equipped with work leads, electrode holders, guns and/or torches.

An engine driven welder (1) per school should be adequate with both constant current and constant voltage output. Minimum rated welding output should be 200 amps cc/cv at 60% duty cycle. The fuel supply can be gasoline, diesel or propane.

C2.2.2 Oxyfuel Gas Cutting and Welding. Five (5) oxyfuel gas cutting/heating/welding torches should be provided for every 20 welding personnel. It is recommended that one (1) oxyfuel gas cutting machine be made available for demonstration and instruction. All oxyfuel gas equipment should be of industrial quality and should be appropriate for the thickness of the material being utilized in the instructional program. A distribution system for piping gases to work stations is recommended, along with one (1) portable cylinder set up per 20 welding personnel. This will facilitate instruction in safely setting up and changing compressed gas cylinders. Flashback arrestors must be provided.

C2.2.3 Plasma Arc Cutting (PAC). Two (2) plasma arc cutting machines should be provided for every 20 welding personnel. Equipment that utilizes compressed air is recommended for cutting. Plasma arc gouging is also a recommended feature. Optional compressed gases can be available, but are not a mandatory part of the cutting package. The plasma arc power source and torch should be rated to cut a minimum of 1/2 inch (12.7 mm) carbon steel at 10 inches (254 mm) per minute travel speed. The plasma arc power source should should have a minimum rated output of 60% duty cycle at 300 amperes.

C2.2.4 Air Carbon Arc Cutting (CAC-A). Two (2) cutting/gouging torch should be provided for every twenty (20) welding personnel. CAC-A equipment uses compressed air for either cutting or gouging. The torch and machine should be rated to cut/gouge a minimum of 1 inch (25.4 mm) carbon steel at 10 inches (254 mm) per minute travel speed. The CAC-A power source should have a minimum rated output of 60% duty cycle at 300 amperes.

ANNEX D
Recommendations for Personal and Shop Materials, Equipment and Tools

INDIVIDUAL EQUIPMENT and TOOLS

Personal protective clothing and equipment

suitable work clothing (to match service conditions for welding process employed, must be fire resistant)

leather jacket, cape, sleeves or apron (optional)

leather gloves

hightop leather safety shoes or boots (steel toed are recommended)

welders hat or skullcap

spectacles w/side shields (clear lens)

burning goggles or face shield (OFC & PAC)
- 2 ea. #5 filter plate/lens
- 2 ea. #7 filter plate/lens
- 4 ea. clear cover plate/lens

noise protection (ear plugs)

welding helmet

welding lenses (to match helmet design)
- 2 ea. #10 shaded filter plate/lens
- 2 ea. #12 shaded filter plate/lens
- 4 ea. clear cover plate/lens

Personal tools

carbon steel wire brush

stainless steel wire brush

16 ounce ball peen hammer

soap stone

- ☐ center punch
- ☐ metal scribe
- ☐ steel dividers (radius maker, min. 6")
- ☐ handheld calculator
- ☐ measuring devices
  - ☐ steel tape measure (minimum 10')
  - ☐ combination square set
  - ☐ english/metric steel bench rule (min. 12")
- ☐ chipping hammer
- ☐ 10" mill file (half round-bastard cut)
- ☐ cold chisel (size optional)
- ☐ pliers, wrenches and clamps
  - ☐ 12" adjustable wrench
  - ☐ tank wrench (optional)
  - ☐ 10" groove or slip joint pliers
  - ☐ 6" side or diagonal cutting pliers
  - ☐ 6" needle nosed pliers
  - ☐ 10" vice grips
  - ☐ 10" vice grip clamp
  - ☐ allen or hex wrench set (to 3/8")
- ☐ screwdrivers
  - ☐ flat head
  - ☐ phillips head
- ☐ oxyfuel friction lighter, flints and tip cleaners
- ☐ flashlight
- ☐ fillet gage

EQUIPMENT and TOOLS

- ☐ first aid kit
- ☐ eye wash station
- ☐ chemical shower
- ☐ fire extinguisher
- ☐ bench vise (medium duty)
- ☐ 4ea. 8" c-clamps
- ☐ grinders (2ea.) and accessories
  - ☐ 4", 4 1/2" or 5" right angle grinder
  - ☐ 7"/9" right angle grinder
  - ☐ 25 ea. grinding wheels (general purpose and aluminum)
- ☐ needle gun or scaler
- ☐ 1 set adjustable wrenches
- ☐ 1 set allen or hex wrenches (to 3/8")
- ☐ 1 set screwdrivers (flat and phillips head)
- ☐ 1 set vice grips
- ☐ steel topped layout or work bench (4'x8'x31" recommended)
- ☐ oxyfuel burning table with dross pan and replaceable slats (4'x8'x31" recommended)
- ☐ work area protective screens (as required)
- ☐ ventilation equipment
- ☐ electrode oven
- ☐ guided bend test jig or machine
- ☐ compressed air supply and accessories (minimum delivery 80 psi @ 8 cfm per station)
  - ☐ 1/2" compressed air hose (length optional)
  - ☐ compressed air regulator (to match system output)
  - ☐ M/F quick couples and adaptors (to accommodate pneumatic tools or air carbon arc cutting torch
  - ☐ hose repair kit with crimping tool
- ☐ arc welding/cutting power source(s) and accessories

Note: Selection of a single multipurpose power source able to meet all welding needs with respect to process, method of metal transfer and materials is limited. Given this limitation, a combination of power sources may be necessary to meet entry level welder training needs.

- ☐ shielded metal arc
  (minimum rating -
  AC/DC - constant current (CC)
  300 amp @ 60%
  - ☐ 25' 2/0 electrode cable
  - ☐ 25' 2/0 workpiece cable
  - ☐ 2/0 cable lugs and connects (to suit)
  - ☐ ground clamp (amp capacity to suit)
  - ☐ electrode holder (to 3/16" capacity)
- ☐ gas tungsten arc
  (minimum rating -
  AC/DC - constant current (CC)
  300 amp @ 60%
  - ☐ high frequency control
  - ☐ gas purge control (optional)
  - ☐ remote control (optional)
  - ☐ water circulation and control (optional)
  - ☐ torch (25', amps and cooling to suit)
  - ☐ accessory kit (to suit)
  - ☐ part repair/replacement kit (to suit)
  - ☐ flow meter(s) (argon, helium service)

- air carbon arc
  (minimum rating -
  AC/DC - constant current (CC)
  300 amp @ 60%)
  - 25' 2/0 electrode cable
  - 25' 2/0 workpiece cable
  - 2/0 cable lugs and connects (to suit)
  - ground clamp (amp capacity to suit)
  - torch (light - medium duty)

- gas metal arc (spray and short circuit)
  (minimum rating -
  DC - constant voltage (CV or CP)
  300 amp @ 100%)
  - 25' 2/0 electrode cable
  - 25' 2/0 workpiece cable
  - 2/0 cable lugs and connects (to suit)
  - ground clamp (amp capacity to suit)
  - wire feeder (to suit power supply and wire diameter)
  - gun (15', amp and cooling to suit)
  - consumable parts kit (.030 - .045)
  - parts repair/replacement kit (to suit)
  - flow meter(s) (CO_2 or mixtures Arg/Oxy, Arg/Co_2)

- flux cored arc
  (minimum rating -
  DC - constant voltage (CV or CP)
  300 amp @ 100%)
  - 25' 2/0 electrode cable
  - 25' 2/0 workpiece cable
  - 2/0 cable lugs and connects (to suit)
  - ground clamp (amp capacity to suit)
  - wire Feeder (to suit power supply and wire diameter)
  - self-shielded gun (15', amp and cooling to suit)
  - gas shielded gun (15', amp and cooling to suit)
  - consumable parts kit (? - 1/16")
  - parts repair/replacement kit (to suit)
  - flow meter(s) (CO_2 or mixtures Arg/Co_2)

- plasma arc
  (minimum rating -
  DC - constant current (CC)
  300 amp @ 60%
  - torch (25', low volt, air primary and secondary)
  - consumable parts kit (to suit)
  - part repair/replacement kit (to suit)
  - air regulator (to suit)

- oxyfuel gas cutting
  - oxyfuel gas cutting torch and accessories
    - cutting torch (manual or combination assembly)
    - oxygen regulator (to suit system)
    - fuel gas regulator (to suit system)
    - 25' oxyfuel gas hose
    - 4 ea. (per unit) 00 - 3/0 cutting tips
    - 4 ea. (per unit) 2/0 gouging tips
    - 1 ea. (per unit) heating tip (optional)
    - consumable parts kit
    - part repair/replacement kit (to suit)
    - cylinder cart
    - tank wrench
    - friction lighter, flints and tip cleaner

  - machine oxyfuel gas cutting
    - machine torch assembly (to suit)
    - drive unit (track burner)
    - rails or track
    - oxygen regulator (to suit supply)
    - fuel gas regulator (to suit supply)
    - 25' oxyfuel gas hose
    - 2 ea. (per unit) 00 - 2/0 cutting tips
    - consumable parts kit
    - part repair/replacement kit (to suit)
    - tank wrench
    - friction lighter, flints and tip cleaner

- Oxyfuel gas supply
  - oxygen supply (capacity to suit)
  - fuel gas supply (capacity and type to suit)

FABRICATION EQUIPMENT (optional)

- ☐ shear 1/4" capacity
- ☐ ironworker
- ☐ pedestal grinder
- ☐ band saw
- ☐ drill press
- ☐ crane (A-frame)
- ☐ cage, cylinder storage
- ☐ tool room, secure storage

MATERIALS

- ☐ drawings or sketches

- ☐ base metal
  - ☐ 3/8" plain carbon steel plate
  - ☐ 3/8" plain carbon steel plate
  - ☐ 10 - 18 gage plain carbon steel sheet (gage size optional)
  - ☐ 10 - 18 gage stainless steel sheet (gage size optional)
  - ☐ 10 - 18 gage aluminum sheet (gage size optional)
  - ☐ useable pieces for all types material (thickness optional)

- ☐ SMAW filler metal
  - ☐ 100# 3/32" E7018
  - ☐ 100# 1/8" E7018
  - ☐ 100# 5/32" E7018
  - ☐ 100# 1/8" E6010
  - ☐ 100# 5/32" E6010
  - ☐ 100# 1/8" E6011
  - ☐ 100# 5/32" 6011

- ☐ GMAW filler metal and shielding gas
  - ☐ 14# spool (per unit) .030 E70-SX
  - ☐ 14# spool (per unit) .035 E70-SX
  - ☐ 14# spool (per unit) .045 E70-SX
  - ☐ 75% argon + 25% CO_2 (capacity to suit) or CO_2 (capacity to suit)
  - ☐ argon + 2-5% O_2 (capacity to suit)
  - ☐ Anti-spatter spray or gel

- ☐ FCAW filler metal and shielding gas
  - ☐ 14# spool (per unit) .035 E71T-1
  - ☐ 14# spool (per unit) .045 E71T-1
  - ☐ 14# spool (per unit) .035 E71T-11
  - ☐ 14# spool (per unit) .045 E71T-11
  - ☐ CO_2 (capacity to suit)

  or
  - ☐ 75% argon + 25% CO_2 (capacity to suit)

- ☐ GTAW electrodes, filler metal, and shielding gas
  - ☐ 4 pkg.. at 10 pc. ea. 1/16" EWTh-2
  - ☐ 4 pkg.. at 10 pc. ea. 3/32" EWTh-2
  - ☐ 4 pkg.. at 10 pc. ea. 1/8" EWTh-2
  - ☐ 4 pkg.. at 10 pc. ea. 1/16" EWCe-2
  - ☐ 4 pkg.. at 10 pc. ea. 3/32" EWCe-2
  - ☐ 4 pkg.. at 10 pc. ea. 1/8" EWCe-2
  - ☐ 4 pkg.. at 10 pc. ea. 1/16" EWP
  - ☐ 4 pkg.. at 10 pc. ea. 3/32" EWP
  - ☐ 4 pkg.. at 10 pc. ea. 1/8" EWP
  - ☐ 4 pkg.. at 10 pc. ea. 1/16" EWZr
  - ☐ 4 pkg.. at 10 pc. ea. 3/32" EWZr
  - ☐ 4 pkg.. at 10 pc. ea. 1/8" EWZr
  - ☐ 40# 1/16" ER70-S2 (carbon steel rod)
  - ☐ 40# 3/32" ER70-S2 (carbon steel rod)
  - ☐ 40# 1/16" ER4043 (aluminum rod)
  - ☐ 40# 3/32" ER4043 (aluminum rod)
  - ☐ 40# 1/16" ER3XX (stainless rod)
  - ☐ 40# 3/32" ER3XX (stainless rod)

  - ☐ 100% argon (capacity to suit)

- ☐ CAC-A electrodes
  - ☐ 4 boxes 1/8" DC copper clad, pointed
  - ☐ 4 boxes 5/32" DC copper clad, pointed
  - ☐ 4 boxes 1/4" DC copper clad, pointed
  - ☐ 4 boxes 3/8" DC copper clad, flat

AWS ENTRY LEVEL WELDER
TRAINING ACHIEVEMENT RECORD

Name: _____ Social Security #: _____ Date Entered Training: _____

Training Facility: _____ Date of Completion: _____

Address: _____

_____

_____

Telephone #: _____

Course, Units and Learning Objectives	Performance Rating	Date Completed	Intructor's Initials	Trainee's Initials
A. Occupational Orientation				
1. Follow safe practices.				
2. Prepare time or job cards [reports or records].				
3. Perform housekeeping duties.				
4. Follow verbal instructions.				
5. Follow written details to complete work assignments.				
B. Drawing and Welding Symbol Interpretation				
1. Interpret basic elements of a drawing or sketch.				
2. Interpret welding symbol information.				
3. Fabricate parts from a drawing or sketch				

Course, Units and Learning Objectives	Performance Rating	Date Completed	Intructor's Initials	Trainee's Initials
C. Arc Welding Principles and Practices				
Unit 1: Shielded Metal Arc Welding				
1. Perform safety inspections of equipment and accessories				
2. Make minor repairs to equipment and accessories.				
3. Set up for shielded metal arc welding operations on plain carbon steel.				
4. Operate shielded metal arc welding equipment.				
5. Make fillet welds, all positions, on plain carbon steel.				
6. Make groove welds, all positions, on plain carbon steel.				
7. Perform 2G - 3G limited thickness qualification tests on plain carbon steel plate.				
Unit 2: Gas Metal Arc Welding				
1. Perform safety inspections of equipment and accessories				
2. Make minor repairs to equipment and accessories.				
3. Set up for gas metal arc welding operations on plain carbon steel.				
4. Operate gas metal arc welding equipment.				
Short Circuit Transfer				
5. Make fillet welds, all positions, on plain carbon steel.				
6. Make groove welds, all positions, on plain carbon steel.				
Spray Transfer				
7. Make 1F - 2F fillet welds, all positions, on plain carbon steel.				
8. Make 1G groove welds, all positions, on plain carbon steel.				

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Course, Units and Learning Objectives	Performance Rating	Date Completed	Intructor's Initials	Trainee's Initials
Unit 3: Flux Cored Arc Welding				
1. Perform safety inspections of equipment and accessories				
2. Make minor repairs to equipment and accessories.				
3. Set up for flux cored arc welding operations on plain carbon steel.				
4. Operate flux cored arc welding equipment.				
5. Make fillet welds, all positions, on plain carbon steel.				
6. Make groove welds, all positions, on plain carbon steel.				
Unit 4: Gas Tungsten Arc Welding				
1. Perform safety inspections of equipment and accessories				
2. Make minor repairs to equipment and accessories.				
3. Set up for gas tungsten arc welding operations on plain carbon steel, aluminum, and stainless steel .				
4. Operate gas tungsten arc welding equipment.				
5. Make fillet welds, all positions, on plain carbon steel.				
6. Make groove welds, all positions, on plain carbon steel.				
7. Make 1F - 2F welds on aluminum.				
8. Make 1G welds on aluminum.				
9. Make 1F - 2F welds on aluminum.				
10. Make 1G welds on aluminum.				

Course, Units and Learning Objectives	Performance Rating	Date Completed	Intructor's Initials	Trainee's Initials
D. Oxyfuel Gas Cutting Principles and Practices				
Unit 1: Manual Oxyfuel Gas Cutting				
1. Perform safety inspections of equipment and accessories				
2. Make minor repairs to equipment and accessories.				
3. Set up for manual oxyfuel gas cutting operations on plain carbon steel.				
4. Operate manual oxyfuel gas cutting equipment.				
5. Perform straight cutting operations on plain carbon steel.				
6. Perform shape cutting operations on plain carbon steel.				
7. Perform beveled cutting operations on plain carbon steel.				
8. Remove weld metal on plain carbon steel using weld washing techniques.				
Unit 2: Machine Oxyfuel Gas Cutting (track burner)				
1. Perform safety inspections of equipment and accessories				
2. Make minor repairs to equipment and accessories.				
3. Set up for machine oxyfuel gas cutting operations on plain carbon steel.				
4. Operate manual oxyfuel gas cutting equipment.				
5. Perform straight cutting operations on plain carbon steel.				
6. Perform beveled cutting operations on plain carbon steel.				

INSTRUCTOR USE ONLY:
Knowledge Related Subject Matter (Classroom Instruction)

Check all boxes where applicable

(A) Occupational Orientation
(B) Drawing and Welding Symbol Interpretation
(C) Arc Welding Principles and Practices
(D) Oxyfuel Gas Cutting Principles and Practices
(E) Arc Cutting Principles and Practices
(F) Welding Inspection and Testing Principles and Practices

	Coursework Completion					
	A	B	C	D	E	F
1. General Welding Safety						
2. Welding Terms and Definitions						
3. Drawing Fundamentals						
4. Drawing Interpretation						
5. Welding Symbol Fundamentals						
6. Welding Symbol Interpretation						
7. Fabrication Principles						
8. Safe SMAW Practices						
9. Safe GMAW Practices						
10. Safe FCAW Practices						
11. Safe GTAW Practices						
12. SMAW Component Identification						
13. GMAW Component Identification						
14. FCAW Component Identification						
15. GTAW Component Identification						

INSTRUCTOR USE ONLY:
Knowledge Related Subject Matter (Classroom Instructon)

Check all boxes where applicable

	Coursework Completion					
	A	B	C	D	E	F
16. SMAW Filler Metal Selection and Identification						
17. GMAW Filler Metal Selection and Identification						
18. FCAW Filler Metal Selection and Identification						
19. GTAW Filler Metal Selection and Identification						
20. SMAW Principles of Operation						
21. GMAW Principles of Operation						
22. FCAW Principles of Operation						
23. GTAW Principles of Operation						
24. SMAW Common Process Variables						
25. GMAW Common Process Variables						
26. FCAW Common Process Variables						
27. GTAW Common Process Variables						
28. Base Metal Identification and Selection (Plain Carbon Steel)						
29. Base Metal Identification and Selection (Aluminum)						
30. Base Metal Identification and Selection (Stainless Steel)						

INSTRUCTOR USE ONLY:
Knowledge Related Subject Matter (Classroom Instructon)

Check all boxes where applicable

	Coursework Completion					
	A	B	C	D	E	F
31. Manual OFC Safe Practices						
32. Manual OFC Component Identification						
33. Manual OFC Principles of Operation						
34. Manual OFC Common Process Variables						
35. Machine OFC Safe Practices						
36. Machine OFC Component Identification						
37. Machine OFC Theory						
38. Machine OFC Principles of Operation						
39. Machine OFC Common Process Variables						
40. CAC-A Safe Practices						
41. CAC-A Component Identification						
42. CAC-A Electrode Identification and Selection						
43. CAC-A Principles of Operation						
44. CAC-A Common Process Variables						

INSTRUCTOR USE ONLY:
Knowledge Related Subject Matter (Classroom Instructon)

Check all boxes where applicable

	Coursework Completion					
	A	B	C	D	E	F
45. PAC Safe Practices						
46. PAC Component Identification						
47. PAC Principles of Operation						
48. PAC Common Process Variables						
49. Visual Examination of Oxygen Cut Surfaces.						
50. Visual Examination of Welds.						

INSTRUCTOR USE ONLY: Testing and Evaluation	Test Attempts (3 Maximum)	Score or Acceptance/ Rejection	Date Completed	Intructor's Initials	Trainee's Initials
Safety Pretest (100% required)					
GMAW-S Workmanship Qualification					
GMAW Workmanship Qualification					
FCAW Workmanship Qualification					
FCAW-G Workmanship Qualification					
GTAW Workmanship Qualification:					
Plain Carbon Steel					
Stainless Steel					
Aluminum					
Summative Closed Book Examination					
SMAW Performance Qualification:					
2G (Horizontal Groove Position)					
3G (Vertical Up Position)					

American Welding Society

Certifies that Entry Level Welder

J. B. WELDER

has completed training, examination, workmanship qualification and performance qualification in accordance with the requirements of the AWS Specification for Qualification and Certification for Entry Level Welders, QC10 and the Guide for the Training and Qualification of Welding Personnel Entry Level Welder EG2.0.

DATE _____ CERTIFICATION DIRECTOR _____

CERTIFICATE NUMBER _____ EDUCATION DIRECTOR _____

ANNEX G
Reference Materials

Safety:

ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes*
ANSI/AWS F2.2, *Lens Shade Selector Chart*

Welding Symbols:

A2.1, *Welding Symbols Chart*
ANSI/AWS A2.4, *Standard Symbols for Welding, Brazing and Nondestructive Examination*

Terms and Definitions:

ANSI/AWS A3.0, *Standard Welding Terms and Definitions*

Filler Metals and Electrodes:

ANSI/AWS A5.1, *Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding*
ANSI/AWS A5.9, *Specification for Bare Stainless Steel Welding Electrodes and Rods*
ANSI/AWS A5.10, *Specification for Bare Aluminum and Aluminum Alloy Welding Electrodes and Rods*
ANSI/AWS A5.12, *Specification for Tungsten and Tungsten Alloy Electrodes for Arc Welding and Cutting*
ANSI/AWS A5.18, *Specification for Carbon Steel Filler Metals for Gas-shielded Arc Welding*
ANSI/AWS A5.20, *Specification for Carbon Steel Electrodes for Flux Cored Arc Welding*

Welding Procedure and Performance Qualifications

ANSI/AWS B2.1, *Standard for Welding Procedure and Performance Qualification*
ANSI/AWS B2.1.001, *Standard Welding Procedure Specification for Shielded Metal Arc Welding of Carbon Steel, (M-1/P-1, Group 1 or 2), 3/16 through 3/4 inch, in the As-Welded Condition, With Backing*
ANSI/AWS B2.1.008, *Standard Welding Procedure Specification for Gas Tungsten Arc Welding of Carbon Steel, (M-1, Group 1), 10 Gage through 18 Gage, in the As-Welded Condition, With or Without Backing*
ANSI/AWS B2.1.009, *Standard Welding Procedure Specification for Gas Tungsten Arc Welding of Austenitic Stainless Steel, (M-8/P8), 10 Gage through 18 Gage, in the As-Welded Condition, With or Without Backing*
ANSI/AWS B2.1.015, *Standard Welding Procedure Specification for Gas Tungsten Arc Welding of Aluminum, (M-22 or P-22), 10 Gauge through 18 Gage, in the As-Welded Condition, with or without Backing*
ANSI/AWS B2.1.019, *Standard Welding Procedure Specification for CO_2 Shielded Flux Cored Arc Welding of Carbon Steel, (M-1/P-1/S-1, Group 1 or 2), 1/8 through 1 1/2 inch thick, E70T-1 and E71T-1, As-Welded Condition*

ANSI/AWS B2.1.020, *Standard Welding Procedure Specification for 75% Argon 25% CO_2 Shielded Flux Cored Arc Welding of Carbon Steel, (M-1/P-1/S-1, Group 1 or 2), 1/8 through 1 1/2 inch thick, E70T-1 and E71T-1, As-Welded or PWHT Condition*

AWS-1-GMAW-S *Welding Procedure Specification for Gas Metal Arc Welding - Short Circuit Transfer on Carbon Steel (M1/P1, Group 1 or 2), 3/16 through 3/4 inch Thick, in the As-Welded Condition*

AWS-1-FCAW *Welding Procedure Specification for Self-Shielded Flux Cored Arc Welding of Carbon Steel, (M-1/P-1/S-1, Group 1 or 2), 1/8 through 1 1/2 inch thick, E71T-11, As-Welded Condition*

AWS-2-GMAW *Welding Procedure Specification for Gas Metal Arc Welding - Spray Transfer on Carbon Steel (M1/P1, Group 1 or 2), 3/16 through 3/4 inch Thick, As-Welded Condition*

AWS-5-GTAW, *Welding Procedure Specification for Gas Tungsten Arc Welding of Aluminum, (M-23 or P-23), 10 Gage through 18 Gage, As-Welded Condition, With or Without Backing*

Visual Examination

ANSI/AWS B1.11, *Guide for the Visual Inspection of Welds*

Oxyfuel Gas Cutting Proces

ANSI/AWS C4.1-G, *Oxygen Cutting Surface Roughness Gauge*
ANSI/AWS C4.1-WC, *Criteria for Describing Oxygen-Cut Surfaces*
ANSI/AWS C4.2, *Operator's Manual for Oxyfuel Gas Cutting*

Arc Welding and Cutting Processes

ANSI/AWS C5.3, *Recommended Practices for Air Carbon Arc Gouging and Cutting*
ANSI/AWS C5.5, *Recommended Practices for Gas Tungsten Arc Welding*
ANSI/AWS C5.6, *Recommended Practices for Gas Metal Arc Welding*
WHB-2.8, *Welding Handbook Volume Two, Welding Processes*

Base Metals (Identification and Selection)

WHB-1.8, *Welding Handbook Volume One, Welding Technology*

Program Implementation and Development

AWS QC10, *Specification for Qualification and Certification for Entry Level Welders*
AWS -OTA, *Occupational Task Analysis, Entry Level Welder*
AWS-ELW-DR *Entry Level Welder - Workmanship and Performance Qualification Drawings (full size 11x17 drawings)*
AWS-WJT, *Resource Guide to . . . Joint-Weld Terminology and Standard Welding Symbols Interpretation (AWS home study course)*